ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL,

VOL. XXI. No. 18.

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ENGINEERING NEWS.

THE NEW CROTON AQUEDUCT REPORT, as lately presented by the N. Y. Senate investigating committee, is divided into a majority and minority report, the dissension being in a few minor points political in their nature. Aside from the connection of Gov. DAVID B. HILL with a certain note of $10,000 endorsed by contractors Clark & O'Brien and a Mr. MULLER, which matter the minority think was improperly brought into this investigation, the committee summarizes the result of its work as follows: The reorganization of the Aqueduct Commission; the immediate cessation of payments for extra excavation and the recognition of other claims amounting to over $1,000,000; stopping the substitution of rubble masonry, for which pay was due, for dry packing, which the contractors had to furnish free; and finally the incidental exposure of much defective work which the contractors had to make good at their own cost. In concluding, the committee figures that it has saved several million dollars to the city of New York, besides better assuring the general safety of the work.

THE CASCADE TUNNEL, on the Northern Pacific R. R., is to be arched with brick, says the Yakima *Herald*, to obviate the trouble arising from dripping water. This water causes the clay road-bed to swell and throws the track out of level.

THE COST OF THE PARIS EXPOSITION to the French Government and city of Paris is estimated at $10,000,000 in a paper on this subject just read by M. FONTAINE before the International Society of Electricians at Paris. As there are 50,000 exhibitors and each will spend on an average $600. This would amount to $30,000,000 more, or an aggregate for the whole cost of the Exhibition of about $40,000,000.

THE ST. CLAIR TUNNEL will perhaps receive a Government subsidy of 15 per cent. on the estimated cost of the work, says the Toronto *Globe*. The cost of the tunnel is figured at $2,500,000.

THE SHIP CANAL now talked of for connecting the Ohio river with Lake Erie had one of its two practicable routes laid down and built upon 50 years ago, says Col. T. P. ROBERTS in an interview in the *Commercial Gazette* of Pittsburg. This was the old canal built by the State of Pennsylvania in 1839-1845. It left the Ohio river at Beaver, 28 miles below Pittsburg, and went by way of New Castle and Conneaut lake to Erie, Pa. The canal was only 28 ft. wide at bottom and 40 ft. wide at top, with 4 ft. of water. The length of the canal was 136⅛ miles, and the lockage, which would be practically the same now, was an ascent of 416⅛ ft. from low-water in the Ohio to Conneaut lake, and a descent to Lake Erie of 509 ft. The water in Lake Erie is about 127 ft. lower than that in the Ohio at Pittsburg.

FOR THIS LAKE ERIE—OHIO CANAL a lay contemporary of Pittsburg suggests the following experiment: As the level of the Ohio river at Beaver is 93 ft. above that of Lake Erie, and we want a canal to Lake Erie, suppose we just head off the Ohio towards Lake Erie in the time of one of its periodical floods, and let Nature caper.

UTAH LAKE, in the Territory of Utah, has been selected by Director POWELL, of the Geological Survey, as a reservoir site. As a consequence the General Land Office has withdrawn all land 10 miles from the lake border from entry or filing.

THE DETROIT BRIDGE QUESTION is under discussion by the board appointed by the War Department, from May 1. The members of the board are Col. POE, Major ALLEN and Major ADAMS, the first two of the U. S. Engineer Corps and the latter of the War Department. The principal contest is expected to take place between the advocates of the "winter bridge" and the defenders of the marine interests.

A FERRY-CAR SYSTEM, says the St. Louis *Globe Democrat*, is being investigated by the engineers, of the Merchants' Bridge, which is to span the Mississippi river at that city. Our contemporary claims that the idea originated with it, and was taken up by the bridge company from the suggestion made. The plan provides for flat cars on low truck wheels, so that wagons and live stock can be driven on them, and thus moved across the river. They will be protected by guards or fences 8 to 10 ft. high, so that it would be impossible for animals to jump over them. The cars will be large enough to admit of driving on two of the heaviest wagons with four-horse teams, and may be made wide enough to admit of two heavy wagons abreast. There will be no difficulty at all in arranging the schedule so that it will not interfere with the regular traffic. It is probable that a train every fifteen minutes would be desirable. The tracks will be arranged with incline switches at either end of the bridge from the approaches, so that the ferry cars can be run down to the road level, an apron dropped, and wagons and stock driven on with the greatest facility. These switches will also be a guarantee against interference with regular traffic, as the ferry cars can be run up the switch and follow a regular train over. The toll will be nominal, and no more than would be charged with a regular wagon way, and in addition to this, teams and stock will have an opportunity to rest while crossing the river.

A BOROUGH STREET ACT is awaiting the signature of the Governor of Pennsylvania, having passed both houses of that State. This act confers authority upon any Borough Council "to require by ordinance and cause to be paved, curbed or macadamized, with brick, stone or other suitable materials, any public street or thoroughfare, or parts thereof, and collect two-thirds of the cost and expense of the same from the owners of the property abutting thereon, by an equal assessment on the feet front." There is a proviso that such improvement shall not be ordered except upon petition of two-thirds of the property-owners representing not less than two-thirds in number of feet of the properties abutting on the street or part thereof proposed to be paved. The other sections relate to the methods of assessment and collection, the filing of the liens, and the methods of procedure for the collection of unsatisfied claims.

A CABLE ROAD IN WASHINGTON, D. C., is to be built there by one of the street railway companies, with about four miles of double track. The working plans are being prepared by Knight & Bontecou, the well-known cable engineers, of Kansas City. Mr. BONTECOU is now in Washington arranging to start the work.

IRON BRICKS, so called, are said to be in satisfactory use for street paving in Germany. These bricks are made by mixing equal parts of finely-ground red argillaceous slate and finely-ground clay, with the addition of 5 per cent. of iron ore. The ingredients thus mixed together are then moistened with a solution of 25 per cent. of sulphate of iron, to which fine iron ore is added. After this, the compound is shaped in a press, dried, dipped once more in a nearly concentrated solution of finely-ground iron ore, and then baked in an oven for about 48 hours, in a reducing flame.

THE INSTITUTION OF CIVIL ENGINEERS, in its new list of members, dated April 1, 1889, shows that powerful body to now number as follows:

	1888	1889	Incr.
Honorary Members	20	19	— 1
Members	1,617	1,657	40
Associate Members	2,458	2,613	155
Associates	461	450	—11
Students	974	989	15
Total	5,530	5,728	198

The increase the year before was 179 and the year before that 180. It is notable that the admissions to the highest grade are only about one-fifth of the whole; in the American Society they are about four-fifths of the whole.

In six years since 1883 the Institution has increased as follows:

	Members, 1882	Incr. to 1889
Honorary Members	20	— 1
Members	1,370	287
Associate Members	1,713	900
Associates	520	—70
Students	765	224
Total	4,388	1,340

This is an increase in members of 21 per cent., and in the other grades of 35 per cent., averaging 30½ per cent.

THE MOST SERIOUS RAILWAY ACCIDENT of the week, and of many weeks, was a derailment on the Grand Trunk Railway, near Hamilton, Ont., on April 28. It is attributed to a broken axle, but appears rather to have been a simple case of frog or switch derailment. The train was an express, and is said to have been running at a high rate of speed. At the Y where trains for the Toronto branch are switched from the main line, the engine jumped the track and ran into a water tank, and the cars were wrecked. The wreck caught fire and a number of persons were burned to death. The total number of killed is said to be 20, and about thirteen were seriously injured. The accident is another illustration of the objections to multiplication of frogs and switches.——A head collision occurred April 26, between two passenger trains on the Baltimore & Ohio, at Baltimore, Md., owing to the signals and switches being set wrong, according to the engineer's statements. The accident occurred at a Y. One engineer broke his leg by jumping, but no one else was seriously injured.——The boiler of a Baltimore & Ohio engine burst April 23, while hauling a passenger train near Utica, Ohio. Nobody was injured.

A WASHOUT occurred April 26 on the Richmond & West Point road. A train was wrecked and 2 men killed.——The surface over the Boston mine at Plymouth, Pa., operated by the Delaware & Hudson Coal Co., caved in April 26.

BRIDGE AND TRESTLE ACCIDENTS are reported as follows: On April 25 a freight train on the Sunbury, Hazleton & Wilkesbarre road went through a burning bridge or trestle near Danville, Pa., and was wrecked. The wreck caught fire and was burned.——On April 25 a Pennsylvania freight train went through a burning bridge at Catawissa. Three men were fatally injured.——The bridge over the Becancour river at Becancour, Que., has been carried away by ice.

THE CHICAGO DRAINAGE BILL has been sent back to the Senate with the unanimous endorsement of the Committee on Waterways and Drainage. Its friends interpret this action as meaning that it will speedily pass the Senate as amended.

ELECTRIC LIGHT, equivalent in illuminating power of 1,700,000 candles, will be used in lighting up the Paris Exhibition.

IMMIGRATION is decidedly falling off. It was for

	1888	1889	Dec. p.c.
Month of March	36,932	29,805	19
3 mos. ending with	69,624	53,304	23
9 " " "	298,281	255,707	13

AN ELECTRIC LIGHT CAR for use at wrecks has just been turned out of the Chambersburg shops of the Cumberland Valley Ry. Co. The car is 33 ft. long, 9 ft. wide, and stands from rail to the highest point of the roof, 13½ ft. The floor is of iron. In one end is a 40 H.P. vertical boiler and a 35 H.P. vertical automatic engine. The engine and boiler rest upon a cast-iron floor plate 9 x 11 ft.

In the other end of the car are two dynamos, one of twenty-five 2,000 C. P. light, the other of fifteen 2,000 C. P. light capacity. The dynamos are connected direct by belting with the engine. In the car are also folding beds, lavatory and all conveniences. Under the car the lamps are carried, and also the tools, etc. Attached to the car is a tender to supply water and coal for the engine. Upon the tender are racks for carrying the poles, hooks for lamps, and a reel for holding the wire. The poles are made of hollow iron piping.

The Kieley Pressure Regulator.

This is a new, simple, and effective device for controlling the pressure of water, and while it does away with the uncertainty of the more common forms of diaphragm action, it is sensitive and absolute in reducing the initial pressure to the desired degree.

In operation, the high-pressure fluid enters the valve at the inlet *A*, Fig. 2, and then passes between the seat and disk through the channel *G*, to the diaphragm chamber. When the desired pressure has been secured, the diaphragm rises, and through the lever *L* the inlet port is closed, and the fluid passes to the outlet pipe with only the desired amount of the initial pressure upon it. As will be seen more plainly in Fig. 1, the amount of leverage, or pressure in other words, is regulated by the simple movement of a pin.

The regulator valve is fitted with a "Jenkins" disk, and this can be replaced in a few minutes when necessary. By closing the valves *H*, Fig. 2, the pressure on the diaphragm is removed, and the full normal pressure at the inlet is permitted to pass the regulator. The claims for superiority in this pressure regulator are based upon the following features: 1. It has no springs to get out of order. 2. It gives the full area of the pipe. 3. Its simplicity and certainty. 4. Its cheapness.

This regulator is the invention of Mr. TIMOTHY KIELEY, 11 West 13th St., New York City, who is also the manufacturer and will furnish any further information on application. It is made in sizes ranging from ¾-in. to 12 ins.

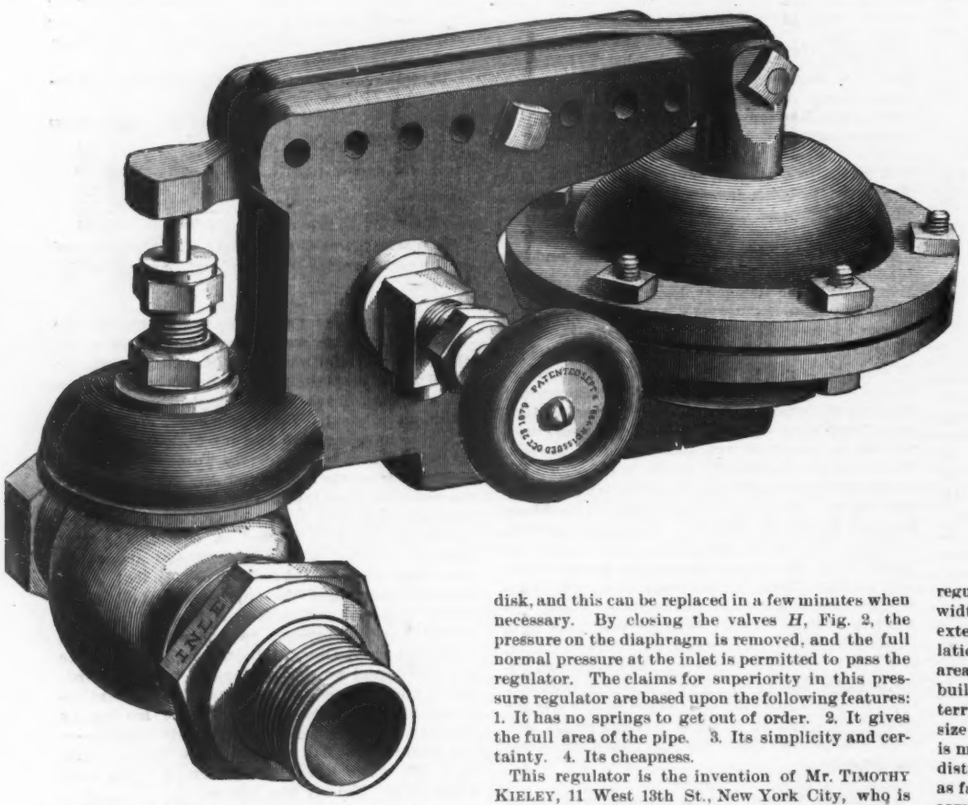


Fig. 1. Kieley Water Pressure Regulator; General View.

THE RAINFALL IN COLORADO thus far this year is reported in the weather bulletin as—1.04 since January 1. This means that the total precipitation since January 1 has been 1.04 inches less than the average total in that time in 16 years. This contradicts the idea that the rainfall in Colorado is increasing; but it does not show that it is decreasing, as observation shows that there are periods of dry and periods of wet years in that State, and this appears to be one of the former. The average precipitation is still nearly 15 ins.

THE TARIFF OF RATES which the Rock Island company publishes on the Iowa lines of its system has printed upon it the following notice:

The rates named in this schedule are unreasonably low and are accepted only for the purpose of avoiding harassing and vexatious litigation threatened by the Railroad Commissioners of the State of Iowa pending the settlement of important questions by the Supreme Court of the United States.

THE gross earnings of the Atchison, Topeka & Santa Fé railway company, all lines for February, amounted to $1,864,982, net earnings, $382,782, an increase of $60,803 over February of last year.

THE special train which carried Dr. W. S. WEBB and party made 61 miles per hour from St. Thomas to Detroit over the Michigan Central. At one point the train made miles per hour.

Gaugings of Sewer Discharge Contemporaneous with Rainfall.

BY EMIL KUICHLING, MEM. AM. SOC. C. E.

(*Concluded from page 380.*)

During the past year seventeen noteworthy rainfalls, ranging in maximum intensity from 0.24 ins. to 3.20 ins. per hour, have been more or less accurately observed in this city at the several stations mentioned, and for nearly all of these the corresponding maximum flow in the sewers was obtained in the manner described. The complete analysis and description of these rains, as deduced from the various records by the writer, are given in full detail in Table No. 21; and a summary thereof, exhibiting only the maximum intensities and durations of the component showers, along with some explanatory remarks, is given in Table No. 22, hereto appended. It should be mentioned that no great accuracy for the figures thus exhibited is claimed, as the rates of the component showers are generally estimates based upon numerous actual measurements; the total precipitation and the timings, however, can be accepted with much confidence in the majority of cases, as the errors are relatively small. The light rains and drizzles are always small fractional parts of the total, fall in the class of storms here considered, and a close knowledge of their intensities can soon be acquired by practice; hence when the duration of these estimated lighter rains is known, together with the total fall, the intensities of the heavy component showers can be reached with a fair degree of certainty. In this manner the rates for the heavy rains were estimated, as shown in Table No. 21; and in the absence of data from the most delicate self-registering rain-gauges, they are submitted as the best which the writer can offer. No revision of them has been attempted in order to secure more harmonious correspondence with the sewer-gaugings, and they are accordingly open to amendment, along with the percentages of discharge.

The storm-discharge from five different districts in this city may now be considered; and for the sake of convenience, the general description of these districts in Table No. 19 is subjoined.

District I.—Discharge measured at gauge No. 2, in the Clifford St. and Avenue B outlet sewer at the intersection of Avenue B and Harris Ave. About one-half of the total irregular tributary drainage area of 356.94 acres has a dense population, averaging about 35 per acre, while the remainder is thinly settled and presents much agricultural land. The soil is generally a clayey loam, with gravel and muck in some places; its surface is slightly undulating, with no sharply-defined natural water-courses. Nearly all of the existing streets are sewered and have graded earthen roadways and gutters, and only a very small proportion of the aggregate length of roadway is macadamized. The average grade of the sewered streets is about 1 in 150, and the sewer grades range from 1 in 47 to 1 in 910. Few large buildings or factories are found in the district. The outlet sewer appears to be in excellent order, and affords good facilities for gauging at all depths of flow.

District IV.—Discharge measured at guage No. 8, in the North Ave. outlet sewer, near Syracuse St. The tributary drainage area of 128.67 acres is generally well-developed, and is in the form of an irregular strip, 4,800 ft. long by about 1,200 ft. average width, beginning in the central part of the city and extending northerly. The average density of population may be estimated at about 32 per acre; the area contains many large business blocks and other buildings along North Ave., but the rest of the territory is occupied chiefly by residences of medium size standard on moderately large lots. The soil is mainly a clayey loam, with muck in the lower districts, and the surface slopes gently to the north as far as the N. Y. C. & R. R. R., after which it becomes very flat. All of the streets are sewered and graded, and about one-third of the aggregate length of roadway has been paved with asphalt, stone blocks, macadam and gravel, the macadam, however, predominating in extent; the remainder of the roadways are of common earth. The average grade of the streets is 1 in 130, and the sewer grades range from 1 in 50 to 1 in 630. The outlet sewer is of good rubble masonry, with a flat bottom excavated in a horizontally stratified limestone rock; for small depths of flow no great accuracy can be expected from the gaugings.

District X.—Discharge measured at gauge No. 18, in the E. Main St. sewer at the intersection of N. Union St. The tributary drainage area of 25.12 acres is well-developed, and is in the form of a long and comparatively narrow strip traversed by E. Main St., along which many large business blocks and apartment houses have been built. There are, however, still many detached small residences on the area, with considerable garden space. The average density of population may be estimated at about 40 per acre. The soil is a clayey loam, and its surface inclines moderately to the east. Every street is sewered and provided with a macadam or gravel roadway, the average surface grade being 1 in 172, while the sewer grades vary from 1 in 70 to 1 in 330. The outlet sewer is of ordinary rubble masonry, with a flat bottom of rock, hardpan or plank. For small depths of flow the gaugings are probably unreliable. From this district the greatest percen

tage of discharge may be expected, as it contains the largest proportion of impervious surface of any in the whole list.

District IX.—Discharge measured by gauge No. 19, in the Court and William Sts. outlet sewer at the intersection of Alexander St. and University Ave. The tributary drainage area of 132.96 acres is chiefly a well-developed residential district, with a few large buildings and apartment houses. Most of the dwellings are large, and stand rather close together on lots of medium size. The average density of population is about 36 per acre. Every street is sewered and graded, and the roadways are nearly all improved with macadam or gravel, but there is not a single first-class pavement in the whole district. The soil is generally of a loamy character, with some clay, gravel and muck in different portions; its surface is somewhat undulating, the prevailing slope, however, being towards the north and east; the average grade of the streets is about 1 in 151, and the sewer grades range from 1 in 54 to 1 in 400. The outlet sewer is of ordinary rubble masonry, with a flat bottom excavated in the limestone rock and trimmed to the slope; hence it is not well adapted to gauging, except when running at considerable depths. From the general character of this district, a relatively large percentage of discharge may be expected.

District XVII. — Discharge measured by gauge No. 30 in the Griffith St. sewer at the intersection of Broadway. The tributary drainage area of 92.27 acres is well sewered and developed, and the average density of population may be taken at about 35 per acre. Every street has been improved, about one-fifth of the aggregate length being paved with asphalt, one-fourth with stone blocks, and the remainder with macadam and gravel. The territory contains a number of large business blocks and apartment houses, but the greater portion is occupied by detached residences, standing on lots of medium width. In one district of about 25 acres, the lots are very deep, and afford opportunity for additional streets. The soil is mainly a clayey loam; its surface slopes generally to the south, but in the aggregate one-half of the whole area is quite flat. The average grade of the streets is 1 in 240, and the sewer grades vary from 1 in 100 to 1 in 350. The sewerage is not of the best description, and the outlet has frequently been overcharged. It is reasonable to infer that the proportion of rainfall reaching the sewers is less than in the preceding district.

The foregoing five districts have been selected from the entire number available because they represent, not only the best developed and most populous localities on the east side, but also the largest and most accessible outlet sewers. It is to be regretted that much doubt with respect to the bottom slope of some of the other sewers, or of the same sewers at other gauges, prevents the utilization of the records obtained until such time as the nominal grades may be tested by numerous excavations; but the computations for several of these other districts show such wide differences and improbabilities as to greatly impair their value; furthermore, most of these districts include large tracts of agricultural or unimproved territory, and are therefore of minor interest in connection with the discharge from populous areas. The combined flow from a series of contiguous districts was measured a number of times by gauges 9 and 10, 11, 12 (*a*) and 13, and 12 (*b*); but as it was impracticable to determine each component separately, the gaugings must necessarily relate to large territories, and can serve only to check the computations made for the smaller areas in which the essential elements were known with reasonable certainty. For these reasons only a part of all the records secured are now of use while the remainder must be laid aside until the sewer grades can be properly verified hereafter.

Some of the details of the discharge computations for the aforesaid fire districts are given in the appended Tables No. 23, 24, 25, 26 and 27, while Table No. 28 shows the computed percentages of the heaviest rainfall as discharged during the period of maximum flow. To exhibit these important results in more convenient and compact form, however, they are herewith submitted in Ttable B.

It will be noticed that there are numerous discordances in this table, most of which can fairly be ascribed to imperfect estimates of the maximum intensity of the rainfall, while the remainder have doubtless arisen from errors made in observing the flood-marks left on the sewer-gauges. Fortunately, however, the data are sufficiently numerous to admit of comparison; and by averaging the results obtained for similar durations of heavy rain, it is probable that the majority of the discrepancies will be equalized, and that the mean values of the percentage of the rainfall so removed by the sewers will afford a clue to the general laws which govern such discharge. For facilitating the study of the problem, these average values for each of the districts were platted as ordinates with the corresponding durations of the maximum rainfall as abscissas, thus obtaining a series of fine, somewhat irregular, curves; and upon carefully examining these diagrams in conjunction with the explanatory remarks relating to both the rainfall and the sewer-gaugings, the irregularities were corrected or equated by suitably fitting regular lines or curves to the various points obtained as stated. These new lines or curves accordingly represent a more or less close approximation to the actual relation of the rainfall to the flood-flow in the sewers of populous districts; and while the numerical results thus reached may not be absolutely correct, the diagrams nevertheless point unmistakably to the following general conclusions:

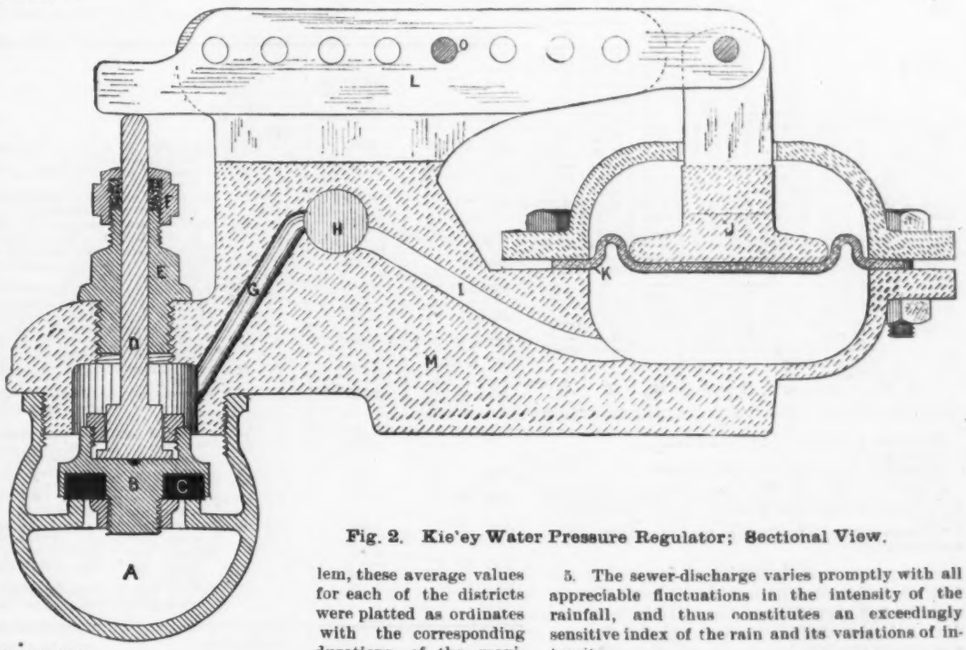


Fig. 2. Kie'ey Water Pressure Regulator; Sectional View.

1. The percentage of the rainfall discharged from any given drainage area is nearly constant for rains of all considerable intensity and lasting equal periods of time. This circumstance can be attributed only to the fact that the amount of impervious surface on a definite drainage area is also practically constant during the time occupied by the experiments.

2. The said percentage varies directly with the degree of urban development of the district, or in other words, with the amount of impervious surface thereon. This fact is clearly shown by the large percentage derived from the relatively best developed, District X., in contrast with the smaller percentages obtained from the relatively less-improved Districts, IX., IV., and XVII., and to the still smaller results yielded by the least-improved District I.; and it also serves to account for the constancy of the percentage discharged from any particular district for rainfalls of the same duration.

3. The said percentage increases rapidly, and directly or uniformly with the duration of the maximum intensity of the rainfall, until a period is reached which is equal to the time required for the concentration of the drainage-waters from the entire tributary area at the point of observation; but if the rainfall continues at the same intensity for a longer period, the said percentage will continue to increase for the additional interval of time at a much smaller rate than previously. This circumstance is manifestly attributable to the fact that the permeable surface is gradually becoming saturated and is beginning to shed some of the water falling upon it; or in other words, the proportion of impervious surface slowly increases with the duration of the rainfall.

4. The said percentage becomes larger when a moderate rain has immediately preceded a heavy shower, thereby partially saturating the permeable territory and correspondingly increasing the extent of impervious surface.

5. The sewer-discharge varies promptly with all appreciable fluctuations in the intensity of the rainfall, and thus constitutes an exceedingly sensitive index of the rain and its variations of intensity.

6. The diagrams also show that the time when the rate of increase in the said percentages of discharge changes abruptly from a high to a low figure, agrees closely with the computed lengths of time required for the concentrations of the storm-waters from the whole tributary area; and hence the said percentages at such times may be taken as the proportion of impervious surface upon the respective areas. For example, the percentage curves for Districts IV. and XVII. are seen to be practically coincident, whence it might be inferred that the proportions of impervious surface are alike in both areas; as a fact, this conclusion is fully warranted by an examination of the two territories, which are separated by a large intermediate area.

The relation between the maximum sewer discharge and the rainfall has thus been approximately established for five different districts in this city, and it has been seen that the flood volume stands in direct proportion to the magnitude of the impervious surface on the drainage area, and to the intensity and duration of the rain; also, that such flood volume reaches practically a maximum when the precipitation continues uniformly for a sufficient length of time to secure the concentration of the storm-waters from all portions of the area. The element of time therefore enters twice into the determination of the flood volume; and from the relation between duration and maximum intensity of the rainfall in this locality heretofore established, we may accordingly find the duration of that particular rainfall for which the sewer discharge will become an absolute maximum. With the following notation: r = maximum intensity of the rainfall in inches per hour; t = duration in minutes of such intensity; Q = sewer discharge in cubic feet per second; A = magnitude of the entire drainage

TABLE P.

Showing the computed percentage of the heaviest rainfall discharged from 5 different city districts by the respective outlet sewers during the period of maximum flow, also the average values of such percentages. Arranged with reference to duration of heaviest rainfall.

Date.	Maximum Intensity of Rainfall Inches per hour.	Duration, of Rain at Max. Intensity Min.	Percentages of Rainfall Discharged. Dist. I. Gauge 24 Trib. Area 506 94 Ac.	Dist. IV. Gauge 8. Trib. Area 128.6 Ac.	Dist. X. Gauge 18. Trib. Area 25.12 Ac.	Dist. IX. Gauge 10. Trib. Area 132.50 Ac.	Dist. XVII. Gauge 30. Trib. Area 92.27. Ac.
Dec. 10, 1887	0.31*	60	13.8	24.1	58.2	41.6	26.0
Sept. 16, 1888	0.47‡	50	19.8	38.2	—	—	37.2
	Avgs.	55	16.8	31.1	58.2	41.6	31.6
May 9, 1888	1.315§ to 0.75†	35	16.4	26.2	52.1	29.0	26.0
April 5, 1888	0.24*	30	10.4	15.5	—	38.2	20.8
May 12, "	0.30*	30	11.0	15.8	35.3	29.6	17.0
	Avgs.	30	10.7	15.7	35.3	34.9	18.9
June 24, 1888	2.62‡	20	6.3	21.1	32.06	13.23	11.86
June 28, "	0.80*	20	14.3	28.7	35.2	35.2	37.4
	Avgs.	20	10.3	24.9	33.6	24.2	24.6
June 2, 1888	0.40‡	15	5.5	9 0	—	37.5	8.7¶
July 11, "	0.76††	15	7.4	15.8	41.2	21.8	19.4
Aug. 16, "	1.61‡‡	15	4.7	12.5	24.7	18.0	19.16
	Avgs.	15	5.9	12.4	32.9	25.8	19.2
May 4, 1888	0.30*	13	6.8	14.4	64.8¶	36.1¶	28.2¶
May 26, "	1.00*	13	8 6	25.9¶	31.8	18.7	11.7
Aug. 4, "	1.00‡	12	4.6	10.3	—	15.0	13.8
Aug. 26, "	2.50†	14	4.0	12.2	33.58	13.88	12.36
	Avgs.	13	6.0	12.2	32.6	15.8	12.6
July 18, 1888	0.75*	10	7.6	12.2	25.0	14.8	10.3
Aug. 17, "	1.33‡	10	5.5	8.7	18.4	11.9	8.9
	Avgs.	10	6.5	10.4	21.7	13.3	9.6
Probable time required for concentration of flow at gauges, Minutes			44	26	16	23	24

*Preceded and followed by lighter rain.
‡Sudden shower " " "
††Heavy shower preceded by lighter rain.
†Intensity roughly estimated.
§Sewer here ran under head; percentage is computed from maximum discharge without head previous to surcharge.
¶Figures obviously too high or too low and rejected in deriving averages.

area in acres; m = proportion of impervious surface on said area, which is also substantially the same as the proportion of the rainfall discharged during the period of greater flow, and with a, b and c = certain empirical constants, we shall have:

$$Q = m\,Ar \qquad 1$$

$$m = at; \qquad 2$$

$$r = b - ct; \qquad 3$$

$$Q = Aat\,(b - ct); \qquad 4$$

and for the usual condition under which Q will become a maximum, we obtain:

$$Aa\,(b - 2ct) = 0, \text{ whence } t = \frac{b}{2c} \qquad 5$$

But in a previous paper, it was shown that the value of the empirical constants b and c was for rainfalls lasting less than one hour in the locality of Rochester, $b = 2.10$ and $c = 0.0305$; hence the duration t of the heaviest rain which will cause Q to become an absolute maximum is: $t = 51$ minutes. This solution, however, is to be regarded simply as a crude approximation, and valid only under certain conditions; but it suffices to show that in drainage areas of moderate size, the heaviest discharge always occurs when the rain lasts long enough at its maximum intensity to enable all portions of the area to contribute to the flow. For larger areas, on the other hand, a more elaborate analysis becomes necessary in order to find under what conditions the absolute maximum discharge will occur, although the method of procedure above indicated will remain the same.

The present percentage of the rainfall discharged from the aforesaid urban districts cannot, however, be regarded as permanent, since improvements are constantly being made by the construction of new buildings, pavements, and sewers; hence, not only is the proportion of impervious surface on these districts steadily growing, but the time required for the concentration of the storm-water in the outlet-sewers is also becoming materially reduced. In planning new curves, therefore, it will be necessary to provide for the drainage from districts which, sooner or later, will be much better developed than any of those described above; and in the absence of more trustworthy data, we may be justified in concluding that the greatest percentages of discharge from such improved districts will continue to be practically equal to the percentage of impervious surface thereon, as was found to be the case with the five districts described. The manner in which the proportion of impervious surface on different classes of urban territory may be estimated has been fully explained in a preceding paper; and as the figures thus obtained are in general accord with observed facts, as well as with the results of the gaugings, the method may accordingly be considered as reasonably accurate. To indicate what figures the writer adopted in computing the maximum flow in the several sections of the proposed east side trunk sewer, it may be repeated here that four different classes of territory were taken into account as follows: Class I, with 50 persons per acre and 55 per cent. of impervious surface; Class II, with 40 persons per acre and 46 per cent. of impervious surface; Class III, with 25 persons per acre and 27 per cent. of impervious surface, and Class IV, with 15 persons per acre and 14 per cent. of impervious surface. It should also be stated that the central districts of the city, which will in the future, undoubtedly, afford a considerably higher percentage of impervious surface than has been assigned to Class I, are not embraced in the drainage area of said trunk sewer; furthermore, that in the estimate of these percentages, a much better condition of the roadways and pavements has been assumed than now prevails.

It has thus been shown that in all localities where ample storm-overflows cannot be secured, the problem of proportioning sewers to remove the rainfall becomes somewhat complicated, and involves not only a thorough knowledge of the details of the rainfall, but also a careful consideration of the future development of the various tributary drainage areas.

Table No. 22—Showing Duration of the Maximum Intensity of the Principal Rainfalls at Rochester, N. Y., from Oct. 1, 1887, to Oct. 1, 1888.

Date	Maximum intensity, inches per hour	Duration of rain at max. intensity	Remarks.
		Hrs. Min.	
Dec. 10, 1887	0.310	1 00	Preceded by 2 hrs. light rain and followed by 1½ hrs. light rain. Uniformly distributed.
April 5, 1888	0.240	0 30	Preceded and followed by light rain lasting from 1 hr. to ½ hr. Uniformly distributed.
May 4 "	0.300	0 13	Preceded by 8 min. moderate rain and followed by 20 min. drizzling rain. Uniformly distributed.
May 9 "	1.315 to 0.348	0 35	Sudden heavy shower, followed by drizzle lasting 1 hr. Direction from S. W. to N. E. Not uniformly distributed. In extreme eastern districts, maximum intensity was only 0 35 ins. per hour.
May 12 "	0.300	0 30	Preceded by 20 min. moderate rain and followed by 10 min. of light rain. Not very uniform.
May 26 "	1.000	0 13	Preceded by short, heavy shower and 15 min. light rain, and followed by short light rain and drizzle. Uniformly distributed.
June 2 "	0.400	0 15	Sudden heavy shower, followed by 50 min. light rain and drizzle. Was a little heavier on west side.
June 24 "	1.000	0 30	Sudden heavy shower No. 1, followed by 27 min. of light rain and drizzle. Apparently uniform.
" "	2.620	0 20	Sudden heavy shower No. 2, followed by 28 min. of light rain. Apparently uniform.
June 28 "	0.800	0 20	Preceded by sharp shower and 45 min. light and moderate rain, and followed by 10 min. light rain, and then by sharp shower. Apparently evenly distributed.
July 11 "	0.760	0 15	Preceded by 30 min. moderate rain. Not very uniform.
" 18 "	0.750	0 10	Preceded by 25 min. light rain, and followed by 45 min. moderate rain. Much heavier on west than east side.
Aug. 4 "	1.000	0 12	Sudden heavy shower, followed by 1 hr. moderate rain with light showers. Probably not very uniform.
Aug. 16 "	1.616	0 15	Sudden heavy shower, followed by 15 min. moderate rain, 3 hrs. previously heavy rain. Not uniform.
Aug. 17 "	1.333	0 10	Sudden heavy shower, followed by 1 hr. moderate rain. Rained some hours previously. Apparently uniform.
Aug. 26 "	3.200 2.500	0 14	Sudden heavy shower with hail, followed by 8 min. moderate rain. Fairly uniformly distributed. Deducting hail, rate would be about 2,5 ins.
Sept. 16 "	0.470	0 50	Sudden heavy rain, followed by 25 min. light rain. Had rained some hours previously. Apparently uniform.

Indian Method of Manufacturing Steel from Wrought-Iron.

In forwarding to the Government Central Museum samples of steel manufactured at a village in the Trichinophy district, together with the ordinary earthenware crucibles used in the operation, the Board of Revenue has also furnished the following communication from the Collector of the District on the method of manufacture:

The industry is carried on at a small village called Venkatanaikampatti, about two miles from Parvaran, kurichi, occupying a favorable situation for obtaining charcoal from the surrounding hills of the Marangapuri Zemindari. It affords employment for about sixteen families of smiths, and is altogether in the hands of a Mussulman named MAHOMED ROUTHEN, who holds a monopoly of the right to collect charcoal for the purpose in the jungles of the estate, for which he pays $4.50 per annum. Beyond the convenience of its situation as regards the jungles and the existence of tolerably fine sod earth in the vicinity, the site possesses no special advantage.

The process employed is very simple. Small quantities of iron are inclosed in a small earthen crucible with a few pieces of the wood of the avaram plant and two or three green leaves. A top is luted on, and when dry the whole is exposed to the heat of a small charcoal furnace till the iron is melted, a fact which the operator ascertains by picking up the crucibles in a long pincer and shaking them. The vessels are allowed to cool and then broken open, when a knob of steel is found at the bottom. Two sizes of ingots are made, weighing about 8 oz. and 10½ oz. respectively. The crucibles are made of a mixture of red earth and charcoal made of paddy husks kneaded together. They are shaped on a wooden plug about 5 ins. long and 2 ins. in diameter for the smaller size of ingot and slightly larger for the other size, having a conical end which forms the bottom of the cavity in which the steel collects while fluid. The lid is of the same material and put on wet. It appears hardly to contract at all in drying, and a fairly air-tight vessel is consequently produced. The clay is not nearly refractory enough for the heat it is exposed to, as the crucibles are completely vitrified and spoilt at the end of a single operation.

The iron used is brought from the Namakal Taluk of Salem, and appears to be a rough description of wrought iron. For the smaller size of ingot, it is cut into pieces weighing as nearly as possible 10 oz. (a small piece is added to make up the weight, if necessary), and this quantity is placed in each crucible with ¾ oz. weight of pieces of the dry wood of the avaram plant. Two or three green leaves (the kind is a matter of no consequence) are placed on top, and the charge closed up with a lump of clay carefully plastered all round. Great care is taken in putting in the correct proportions of iron and avaram wood, and the operators assert that, if less is used, the iron is not melted, and if more, it will not stand being worked afterwards. The green leaves probably serve in some way towards retarding the drying of the lid and preventing it from cracking.

The furnace consists of an inverted cone of earthwork about 2 ft. in diameter, and the same in depth, the apex opening into an ash-pit below. At one side, and protected from the heat by a mud wall, is a small shed in which two bellows-men sit and work a couple of skin bellows most vigorously. The air is admitted into the furnace through a hole near the bottom. In preparing a furnace, some straw is first placed at the bottom below the air-hole, and charcoal is then thrown in to a suitable height. On this, 25 of these conical crucibles are placed with the points downwards, and, when all are in position they appear to form a sort of circle and to be independent of the layer of charcoal below. More charcoal is placed

above, and the furnace is then lighted through the air-hole. Fresh fuel is thrown on above from time to time and one or two of the crucibles are occasionally lifted with long-handed pincers to allow the burning charcoal to fall through and replenish the supply below. The straw remains untouched by the fire throughout the process. The crucibles are given a sharp shake on these occasions, which is said to assist the process, and, toward its conclusion, allows of the operator's ascertaining whether the iron is melted or not. As the mouth of the furnace is open, the waste of fuel is enormous, and I do not believe that one fourth of the charcoal used exercises any effect on the crucibles. In the absence of good fine clay, this fault seems irremediable, as there is no sufficiently refractory material available from which a separate opening for the supply of charcoal to the furnace below could be constructed.

After about an hour or an hour and a half the feel of a crucible when lifted shows its contents to be liquid. The process is then considered to be completed, and the crucibles allowed to cool, after which they are broken open, a knob of steel found at the bottom of each. The ingots are reheated and hammered into oblong pieces, in which shape they are sold. All the crucibles do not remain absolutely air-tight during the process, the lids becoming cracked without affecting the result. I had the contents of one of these poured out through a crack, and was surprised to find the steel in a state of extreme fluidity, a thing which the heat produced hardly led me to expect.

The estimated cost of making 200 lbs. of steel is about $13.95, and the value realized for the produce about $16.20, the manufacturer netting a profit of $2.25. The annual out-put of the manufacturers in the village is about 28,000 lbs.—*The Indian Engineer.*

Air Compressed by Water Power.

The compression of air by water-power at some convenient point, and its pipage to the place of use, is no new engineering feat. Air compressed in this manner was used to drive the machinery at the St. Gothard tunnel; and perhaps the most complete and extensive plant in the United States is that of the Hydraulic Power Co., of Michigan, which works all the machinery of the Chapin and Ludington iron mines by air compressed at the Quinnesec Falls, three miles away. But it is not every one who knows how the water-power is applied to the air-compressor; and to enlighten interested readers a simple and effective engine, designed for the application of water-power by the Rand Drill Co., of New York, is herewith illustrated.

The cut shows the general plan and elevation of a 14 x 12 in. duplex water-power compressor. It is operated by an impulse water-wheel mounted directly upon the compressor shaft, and this wheel is so designed in relation to the available head and quantity of water, that its revolutions in a given time just equal those for which the compressor is proportioned. The weight of this wheel also acts as a fly-wheel. Of course the wheel is encased so as to avoid the spraying of the water. The efficiency of these wheels has been on tests as high as 90.2 per cent.; and the makers say that they can be relied upon for 85 per cent. in practice.

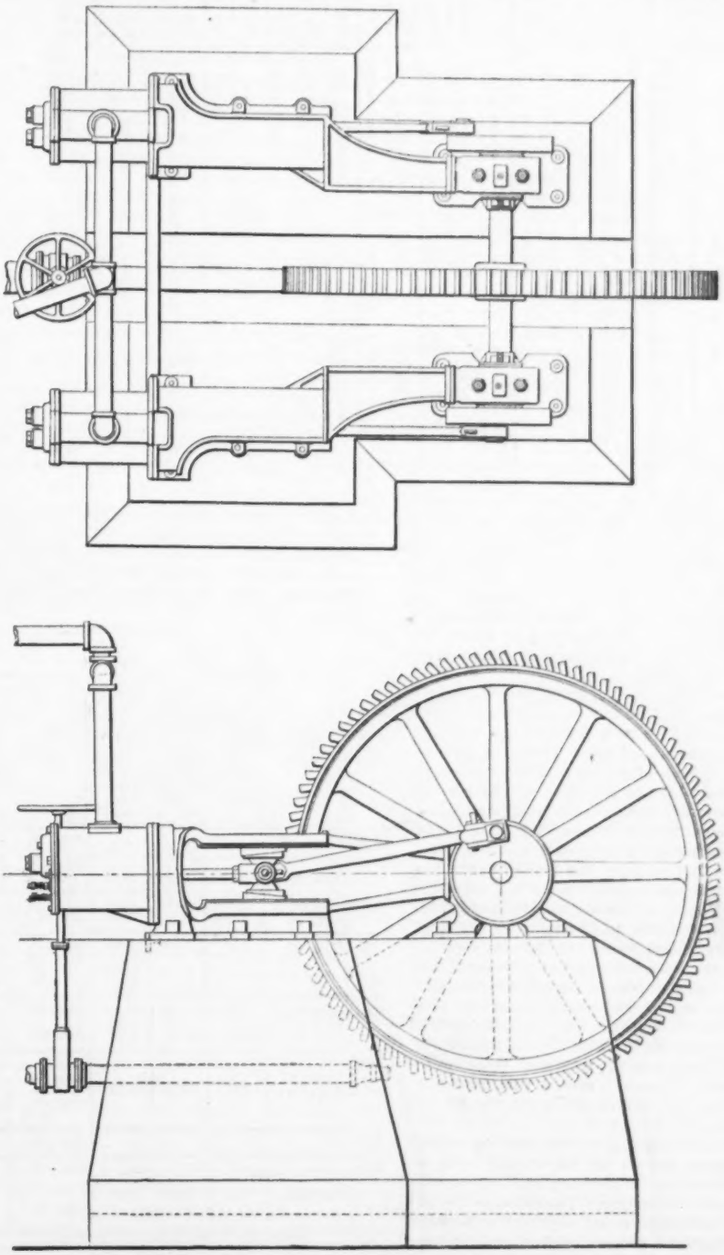
The same device has been applied to pumps and to hoisting engines, two wheels being used in the latter case with two jets impinging on the buckets from opposite directions. The advantages claimed are—no belting, no gearing, no shaft transmission with its inherent loss of power, and little or no liability to break down.

SOME LONG PILES.—There is some pretty soft mud in the swamps down South, if the following, from the Montgomery, Ala., *Advertiser*, is to be believed:

The bridge contractors on the Georgia Southern & Florida have struck it "soft" in Mud Swamp, 3 miles south of Valdosta, Ga. The piling cut for the bridge were 80 ft., and it was supposed that they were plenty long enough, but not so. When one of them was driven out of sight, they got others 60 ft. long; and when one 60 ft. long was driven out of sight, they put another on top of it, and another, and at last accounts they had gone down 166 ft., and they were still going down 11 ins. at each blow from the hammer. There is no telling where the bottom is. The bridge at this point is to be 900 ft. long, and if the whole span is as deep in mud as at the spot where they began the pilings, the company will have a serious time getting the bridge in place.

The Practical Value of Self-Recording Rain Gauges.*

"What are the uses of self-recording meteorological instruments?" is a question that is frequently asked. This question may be readily answered by saying that it is very generally conceded at the present time that they are absolutely essential for an intelligent study and comparison of meteorological phenomena. In order to answer this question in a more practical manner, however, with regard to self-recording rain gauges, the writer has prepared the two following tables, and the remarks and illustration which are included in this paper.



Duplex Water-Power Air Compressor; Made by the Rand Drill Co.

The tables contain interesting data relative to excessive rainfalls, and were compiled from diagrams taken from self-recording rain gauges, that were operated under the direction of the City Engineer's Department, at three different stations in Providence, R. I., and its environs. For convenience of description, the three stations will be designated, when they are referred to in the future, by the numbers 1, 2 and 3. Their relative positions with regard to each other are as follows: Station No. 2 is situated about 1¼ miles southerly from Station No. 1, and Station No. 3 is situated about 6 miles southwesterly from Station No. 1.

The Draper pattern of self-recording rain gauges were used, and although they were not of the most modern construction, all the data contained in the tables are sufficiently accurate for practical purposes, and in the cases of the more excessive rates of rainfall are very reliable. The data of only the seven warm months of each year, from April to October, have been included in the tables, as during the cold months the pipe of each rain gauge connecting the funnel that receives the rainfall with the recording apparatus at times gets clogged with ice or snow; consequently, there is often a question of doubt during these months as to the reliability of the recorded rates.

With an ordinary rain gauge, it is not possible to determine the rate per hour of the fall of rain during a storm, without noting the time that it is raining with a watch; and as it is very inconvenient in the majority of cases to do this, it is very rarely done, and when it is, an average rate is all that is generally

* A paper read at a meeting of the New England Meteorological Society, April 17, 1889, by EDMUND B. WESTON C. E., member of the Council of the Society.

TABLE NO. 1.

This table shows the number of times that rates of rain from ¼ to 6 inches per hour were recorded at Stations Nos. 1, 2 and 3, during the seven warm months of a number of years; also the average maximum and minimum amounts that fell while it was raining at these rates.

Stations. Years. Elevation of the funnels of the rain-gauge above the surface of the ground.		Rates per Hour. Including ¼" to ½". No. of Times.	Amount at this rate in inches. Aver.	Max.	Min.	Including ½" to 1". No. of Times.	Amount at this rate in inches. Aver.	Max.	Min.	Including 1" to 1½". No. of Times.	Amount at this rate in inches. Aver.	Max.	Min.	Including 1½" to 2". No. of Times.	Amount at this rate in inches. Aver.	Max.	Min.	Including 2" to 2½". No. of Times.	Amount at this rate in inches. Aver.	Max.	Min.	Including 2½" to 3". No. of Times.	Amount at this rate in inches. Aver.	Max.	Min.	Including 3" to 4". No. of Times.	Amount at this rate in inches. Aver.	Max.	Min.	Including 4" to 6". No. of Times.	Amount at this rate in inches. Aver.	Max.	Min.	Including 5" to 6". No. of Times.	Amount at this rate in inches. Aver.	Max.	Min.
Station No. 1. (21 feet.)	1878																									1	1.50	1.50	1.50									
	1879	5	.36	.60	.26	5	.37	.63	.25	3	.29	.31	.28	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	1880	3	.37	.5	.25	6	.65	1.25	.25	2	.34	.40	.27	1	.38	.38	.38	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	1881	3	.66	1.40	.28	3	.42	.50	.26	2	.32	.33	.30	2	.31	.38	.30	....	....	....	....	3	.38	.50	.30	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	1882	1	.30	.30	.3	4	.40	.49	.31	3	.42	.6	.30	1	.35	.35	.35	3	.38	.48	.33	2	.40	.45	.35	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	1883	3	.3	.41	.33	2	.36	.36	.36	1	.28	.8	.2	....	....	....	....	1	.31	.3	.31	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	1884	3	.43	.5	.26	2	.34	.41	.27	3	.3	.45	.26	1	.44	.44	.44	....	....	....	....	....	....	....	....	1	.45	.45	.45	....	....	....	....	....	....	....	....	....	....	....
	1885	5	.39	.7	.25	5	.39	.62	.2	2	.61	.89	.32	....	....	....	....	....	....	....	....	....	....	....	....	1	.27	.27	.27	1	.29	.29	.29	....	....	....	....	....	....	....
	1886	6	.37	.57	.25	1	.30	.30	.30	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	.50	.50	.50	....	....	....	....	....	....	....	....	....	....	....
	1887	7	.31	.40	.26	5	.32	.38	.32	6	.51	1.27	.28	....	....	....	....	....	....	....	....	....	....	....	....	1	.50	.50	.50	....	....	....	....	....	....	....	....	....	....	....
	Totals.	36				33				22				5				4				5				4				1				....						
Station No. 2. (15 feet.)	1878	2	.25	.25	.25	7	.32	.49	.25	4	.8	2.00	.25	1	.35	.35	.35	....	....	....	....	1	1.00	1.00	1.00	....	....	....	....	....	....	....	....	....	....	....	....	1	3.50	3.50	3.50
	1879	6	.28	.35	.28	3	.27	.30	.25	4	.38	.50	.25	3	.51	1.10	.25	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	1880	3	.33	.40	.25	5	.45	.48	.30	5	.52	1.00	.20	1	.50	.50	.50	3	.63	1.00	.40	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	Totals.	11				15				13				5				3				1				....				....				1						
Station No. 3. (14 feet.)	1878	11	.31	.50	.25	5	.38	.50	.25	4	.28	.50	.2	....	....	....	....	1	2.00	2.00	2.00	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	1879	5	.27	.30	.25	6	.9	3.92	.2	2	.55	.85	.25	2	.43	.50	.35	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	1880	7	.29	.50	.25	5	.52	.85	.38	3	.58	1.0	.25	1	1.25	1.25	1.25	2	.70	1.00	.40	1	1.30	1.30	1.30	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	1881	2	.3	.50	.25	6	.48	.82	.28	2	.74	.42	.25	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	1882	8	.29	.48	.25	8	.48	1.40	.30	1	.45	.45	4	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	1883	9	.31	.50	.28	....	....	....	....	1	.30	.30	.3	....	....	....	....	....	....	....	....	....	....	....	....	1	.50	.50	.50	....	....	....	....	....	....	....	....	....	....	....
	1884	9	.35	.50	.25	1	.60	.50	.50	2	.67	.94	.40	2	1.25	2.00	.50	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	Totals.	51				31				15				5				3				1				1				....				....						

ascertained, although it may have been raining faster or slower at intervals during the time noted.

By the use of a reliable self-recording rain gauge the different rates that rain has fallen during a storm can be readily determined. The writer was under the impression, before he commenced to study the diagrams of self-recording gauges, that a rate of rainfall of 1 in. per hour was of a very unusual occurrence; a short experience with them, however, dispelled this idea.

It has been a great source of trouble to many civil engineers during the last few years, when so many sewerage systems have been designed and built, to obtain reliable and useful rainfall data, in order to determine what sizes of sewers will be required to provide for the whole or a portion of the rainfall of the localities under consideration. The majority of meteorological records are of very little use in this respect, as generally it is only possible to obtain from the best of them the depth of rain, the date of the storm, and the time when it commenced and ceased. The writer on one occasion, about fifteen years ago, was able to find in one of the most reliable meteorological records in this country, indications of only eleven times during 40 years when it had rained at a rate of 1 in. per hour or more; this is equivalent to an average of a little less than two and a half times in 9 years. This is quite different from the data given in Table No. 1 of this paper, which show that during 9 years, there were 41 times when it rained at a rate of 1 in. per hour or more, at one or more intervals during the storms that occurred in this period.

As a practical illustration, the writer will mention a case that came within his knowledge quite a number of years ago. A civil engineer was called upon to design and superintend the construction of a system of sewers for a small city, and as he was not familiar with the rainfall of the locality, his only resource, as there was but one self recording rain-gauge known to be in operation in the country, and that was many miles away, was to consult "the old inhabitant" and to examine some records of rainfall, that had been carefully kept in the vicinity with the aid of an ordinary rain-gauge, during a period of 30 years. After a careful study of these records, he made up his mind as to the amount of rainfall to be provided for, and determined the size of the sewers accordingly. Fortunately only a few miles of sewers were built during the two or three years that followed the completion of his plans, as before the end of that time it was plainly demonstrated that allowance had not been made for a sufficient amount of rainfall, as at times, during a number of storms, the sewers overflowed into the streets in which they were built, as well as into the cellars of many of the buildings in the neighborhood, causing a great deal of inconvenience and damage; the final result was that additional sewers had to be built to take away surface water in some of the streets where sewers had already been constructed, and many features of the original design changed. Without doubt, the greater part, if not the whole, of this trouble could have been obviated, if records of self-recording rain gauges had been available.

Table No. 1 gives the number of times, or intervals, that rain fell during the seven warm months of the year, for a period of years, at the rates per hour, from ¼ to 6 ins., given in the different divisions into which the table is divided, when the amounts that fell during the interval or intervals that it was raining at the given rates were not less than one-quarter of an inch. When the rate of rainfall per hour is mentioned, it is not intended to imply that the total amount expressed by the rate fell during one hour, but simply to convey the idea what any amount of rain that fell during a fraction of an hour, would have been, had it continued to fall with the same rapidity during the whole hour; or if the duration of the rain was more than one hour, what it would have been had it been limited to one hour. For example, let us suppose that during a heavy fall of rain the time was noted, and it was

TABLE No. 2.

This table contains data of a number of remarkable storms, when excessive amounts of rain continued to fall for a considerable length of time, that were recorded during the seven warm month of each year, from 1878 to 1888 inclusive, at Providence, R. I., at Stations Nos. 1, 2, and 3. The table does not include, however, any amounts of rain (if there were such) that fell during the storms at a rate of less than 5-100 of an inch per hour, or the time that it was raining at this rate.

Year	Station No. 1 Date of Storm	Depth of rain in ins. that fell during the storm	Time in fractions of an hour that it rained during the storm	Rate of rain per hour, according to the two preceding colum's	Station No. 2 Date of Storm	Depth of rain in ins. that fell during the storm	Time in fractions of an hour that it rained during the storm	Rate of rain per hour, according to the two preceding colum's	Station No. 3 Date of Storm	Depth of rain in ins. that fell during the storm	Time in fractions of an hour that it rained during the storm	Rate of rain per hour, according to the two preceding colum's	Year
1878	.....	.....	.....	.....	June 22.	0.50	0.50	1.00					1878
					" 22.	1.94	2.00	0.97	June 22.	2.10	2.00	1.05	
					Aug. 2.	0.62	1.50	0.42	Aug. 2.	2.30	4.00	0.57	
	Aug. 6.	2.51	1.00	2.51	" 6.	4.49	1.00	4.49	" 6.	1.15	2.00	0.58	
1879	Aug. 16-19.	2.44	10.50	0.23	July 16.	0.52	2.00	0.26	Aug. 16,19	5.30	17.00	0.31	1879
	" 14.	0.38	0.75	0.51	Sept. 3-4.	1.98	4.00	0.50	Sept. 3-4	1.80	7.00	0.26	
1880	July 16.	1.38	1.50	0.92	July 16.	1.32	2.00	0.66	Aug. 3-5.				1880
					Aug. 3-5.	3.62	9.00	0.40	" 25.	6.10	13.00	0.47	
					" 21.	1.00	1.00	1.00	" 29-30.	0.42	0.50	0.84	
										1.88	3.00	0.63	
1881	June 24.	1.27	1.75	0.73	June 28.	0.98	1.75	0.56					1881
	July 4.	0.77	1.10	0.64									
	" 26.	2.45	6.00	0.41	July 26.	2.13	5.50	0.39					
1882					July 2.	0.50	1.00	0.50					1882
					Aug. 8-9.	0.50	0.25	2.00					
	Aug. 24.	0.75	0.75	1.00	" 24.	0.95	0.50	1.90					
					Sept. 9.	1.50	1.25	1.20					
					" 22-23.	4.04	8.00	0.51	Sept. 22-23.	3.75	10.00	0.38	
1883	.....	.....	.....	.....	May 22.	3.52	12.00	0.29	.....	.....	.....	.....	1883
1884	.....	.....	.....	.....	June 19.	1.06	1.67	0.63	June 19.	1.47	2.00	0.73	1884
									" 25-26.	3.48	5.00	0.70	
	July 8-9.	0.42	0.79	0.53					July 8.	2.50	3.00	0.83	
					July 31.	0.60	0.67	0.90	" 31.	0.70	1.00	0.70	

found that it took fifteen minutes for ¼ in. to fall; this is equivalent to a rate of 2 ins. per hour. In the first division of the table (No. 1) are given the rates from ¼ in. per hour to ½ in. not including the ½ in., and in the second division, the rates from ½ in. per hour to 1 in., not including the 1 in., and so on to 6 ins. In the first column of each division are given the number of times, or intervals, that it rained at the given rates during the storms that occurred in the seven months of each year before mentioned. The figures in this column are not repeated in any instance, or in other words, the figures in the first column of the division devoted to rates from ¼ to 1 in. are not repeated in the first column of the division devoted to rates from ½ to ½ in., etc. In the second column of each division are given the average of all the amounts of rain that fell, at the given rates during the entire storms, or at one or more times during the storms of the seven warm months of each year. In the third column of each division is given the maximum amount of rain that fell at the given rate at any one time during the seven warm months of each year. In the fourth column of each division is given the minimum amount of rain that fell at the given rate at any one time during the seven warm months of each year. The time in fractions of an hour that it took the amounts of rain to fall that are given in the second, third, and fourth columns, that have just been mentioned, can be ascertained by dividing the amounts in these columns by the rates which are given at the heads of their respective divisions.

Table No. 2, which was arranged for a purpose similar to that of Table No. 1, although the information that it contains is somewhat different, gives the data of a number of remarkable storms, during which excessive amounts of rain fell for a considerable length of time, during the seven warm months of each year from 1878 to 1884 inclusive. This table (No. 2) is divided into three divisions, one division being devoted to data obtained from the diagrams of a self-recording rain gauge, that was located at one of the three stations before mentioned. In the first column of each division is given the data of the day or days of the month that the storms occurred. In the second column of each division are given the amounts of rain that fell at rates of $\frac{1}{10}$ in. per hour or more, during the entire storms, or at one or more intervals during the storms. In the third column of each division is given the time, in fractions of an hour, that it rained at a rate of $\frac{1}{10}$ in. or more during the whole of each storm, or at one or more intervals during each storm. In the fourth column of each division are given the average rates of rainfall per hour, computed from the data given in the second and third columns.

It is more than likely that there were a number of remarkable storms, and periods when excessive amounts of rain fell during the seven warm months of the years mentioned, that are not included in Tables Nos. 1 and 2, as on several occasions the self-recording rain gauges were (unavoidably under the circumstances) out of order, or could not be attended to in a proper manner.

In order to give an idea of the practical value of the tables, the writer will assume, for instance, that it is necessary to determine the size of a main sewer, of sufficient capacity to take away the ordinary rainfall, as well as the sewerage, of an area of 65 acres, situated in the center of a compactly built-up city, and that the grade to which this sewer must conform will pitch at a rate of 2 ft. per 1,000 ft. In a case of this kind, it can be assumed, more especially in this part of the country, that the amount of sewerage will be very small in proportion to the amount of rainfall, and that all the rain, when falling at excessive rates, will be conducted into the sewer as fast as it falls. It can be seen by consulting Table No. 1 that it rained (considering the data of Station No. 1 only) 36 times at a rate between ¼ and ½ in. per hour, 33 times at a rate between ½ and 1 in., 22 times at a rate between 1 and 1½ ins., 5 times at a rate between 1½ and 2 ins., 4 times at a rate between 2 and 2½ ins., 5 times at a rate between 2½ and 3 ins., 4 times at a rate between 3 and 4 ins., and 1 time at a rate between 4 and 5 ins. At the grade previously mentioned, sewers of the following dimensions would be required to carry away the rain falling at 6 of the rates given in Table No. 1, viz.: For a rate of ½ in. per hour, a sewer 38 ins. in diameter; for a rate of 1 in., a sewer 64 ins. in diameter; for a rate of 3 ins., a sewer 74 ins. in diameter; for a rate of 4 ins., a sewer 82 ins. in diameter; and for a rate of 5 ins., a sewer 88 ins. in diameter. In any of these cases, the sewer would probably be flowing full, and to the extent of its capacity, under the conditions named, before ½ in. of rain had fallen. It is probably well known, however, that it is not customary to go to the expense of building sewers of sufficient size to provide for excessive rainfalls, which rarely occur, as it is generally considered more judicious to bear the expense of making repairs arising from overflows and washouts, should they occur under these circumstances. For instance, in the case of the sewers just mentioned, it would probably cost, under ordinary circumstances, in the neighborhood of $7,500 more to build an 88-in. sewer, 1,000 ft. long than it would to build a 38-in. sewer of the same length, assuming that the axis of each was to be at a common depth of 10 ft. below the surface of the ground.

As an example of the value of self-recording rain gauges for the purpose of studying local rain storms, the writer would especially call attention to a remarkable storm that occurred during the afternoon of the 6th of August, 1878, when the amount of rain that fell per hour was and is without precedent in Providence. At Station No. 2, the duration of the rain was 1 hour, and the total depth that fell within this hour was 4.49 ins., but during a portion of the time 3.50 ins. fell at the rate of 5.83 ins. per hour; at Station No. 1 the duration of the rain was the same as at Station No. 2, the total depth that fell within the hour was 2.51 ins., and the maximum rate was 3 ins. per hour, for an amount of 1 $\frac{50}{100}$ ins.; at Station No. 3, the duration was 1 and ¼ hours, the total depth of rain that fell was 1 $\frac{30}{100}$ ins. and the maximum rate was 1 in. for a depth of $\frac{40}{100}$ ins.

Many more instances could be mentioned relative to the value of self-recording rain gauges, in which their diagrams have played an important part, such as substantiating testimony in courts of law, as well as in furnishing much valuable information for many other purposes, but time will not admit.

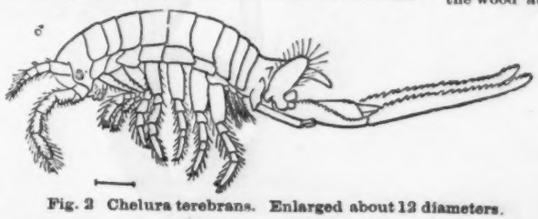


Fig. 2 Chelura terebrans. Enlarged about 12 diameters.

The writer will, however, in closing give one more example bearing upon the subject, which relates to the duration of rainy weather. The diagrams that have been taken from the self-recording rain gauge at Station No. 3 show that rain actually fell at this station 1,788 hours, or a little less than 7 per cent. of the whole time, during the 6 warm months of the year from May to October inclusive, of the 6 successive years from 1879 to 1884 inclusive. The data obtained from the records of this station are more especially mentioned on account of the top of the funnel of the gauge located there being within 1 ft. of the surface of the ground, so that there is probably no doubt that the smallest amounts of rain were recorded; this gauge was also in running order during the entire time, with but a few exceptions, when the hours that the rain commenced and ceased were noted by observation.

The Limnoria in Boston Harbor.

The last report of City Engineer JACKSON, of Boston, Mass., contains an interesting chapter on the marine life destructive to submerged timber in and about that city. During the last year a careful examination of the piling beneath portions of eleven bridges was made by a diver, under the direction of Assistant Engineer HENRY MANLEY. In only two cases was serious damage found due to the *Limnoria* or pile-worm, and both of these were previously known.

There are three marine animals on the Atlantic coast of the United States that do most serious damage to submerged woodwork; but only one of these, the *Limnoria terebrans*, or *Limnoria lignorum* of the naturalists, is found in Boston waters in any considerable numbers. It is not found in brackish waters, and sewage-contaminated water is not favorable to it. It most abounds in the clear water of the lower harbor. Spruce and soft woods are rapidly eaten, white oak piles endure much longer. The oak wharf at Deer Island lasted 24 years before the ravages of the *Limnoria* were sufficiently serious to require its reconstruction.

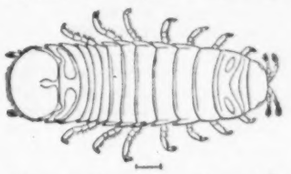


Fig. 1 Limnoria lignorum, or Limnoria terebrans. Enlarged 10 diameters.

Mr. GEO. BROWN GOODE, in "The Fisheries and Fishery Industries of the United States," 1884, speaks in substance as follows of the "gribble" or boring *Limnoria* and some others of like nature:

This little crustacean pest, which is less than one fourth inch long (see Fig. 1), is found from the Gulf of St. Lawrence to Florida. In spite of its small size, it is very destructive of all kinds of submarine woodwork, which it rapidly eats away. It makes its burrows by means of stout mandibles or jaws, is grayish in color and is covered on the upper part of the body with minute hairs to which more or less dirt usually adheres.

This *Limnoria lignorum*, or "gribble," generally lives above and just below low-water mark, though it has been found, but rarely, as low as 7 to 10 fathoms. The burrows are about one-half inch deep, and when they have become numerous enough to reduce the superficial layer of wood to a mere shell, this scales off and leaves a fresh surface, which is at once attacked. It has been observed cutting the gutta-percha of submarine telegraph cables. The burrows are nearly round, and of all sizes up to about one-sixteenth inch in diameter; they go into the wood at all angles and are usually crooked. It works chiefly in the softer parts of the wood, between the harder annual layers, and it avoids knots, rusted portions around nails, etc.

When abundant, it will destroy soft timber at the rate of a half inch or more every year, or reduce the diameter of a pile one inch per year. Unlike the *Teredo*, this creature is a vegetarian and it eats the wood it excavates, so that its boring operations provide it with food and shelter. The usual remedies adopted to check its ravages are chiefly, copper or other metallic sheathing; driving broad-headed iron nails close together in the parts subject to attack; or the application of coal-tar, creosote, or verdigris paint once a year or oftener.

The two other marine animals destructive to wood are the *Teredo navalis* and the *Chelura terebrans* (Fig. 2). The *Teredo* is well known as a long, soft worm that may be as much as 18 ins. long and three-eighths inch in diameter. It burrows in the interior of timber and is abundant on the southern coast of Massachusetts, but it is not found north of Cape Cod. Of the *Chelura*, Mr. GOODE says, that while it is common on the European coast from southern Norway to the Adriatic Sea, it has so far only been noticed on the Atlantic coast of the United States at Wood's Holl and Provincetown, Mass. At both places it is found associated with the *Limnoria lignorum* in the submerged piles of old wharves. It is quite easy for the unskilled eye to confound it with the *Limnoria*, though they belong to very distinct divisions of the *Crustacea*. The *Chelura* was first identified in the United States by Prof. S. I. SMITH, of New Haven.

THE WORLD'S TOTAL PRODUCTION OF COAL last year amounted to 430,000,000 tons, of which the total output in the United States was 130,000,000 tons, or a little more than 30 per cent. of the whole. The product of Pennsylvania in 1888 amounted to 38,000,000 tons of anthracite and 33,000,000 tons of bituminous coal, or about 55 per cent. of the whole supply of this country. The annual production of anthracite coal has steadily increased from 29,000,000 tons in 1882 to 38,000,000 tons in 1888.—*Philadelphia Record.*

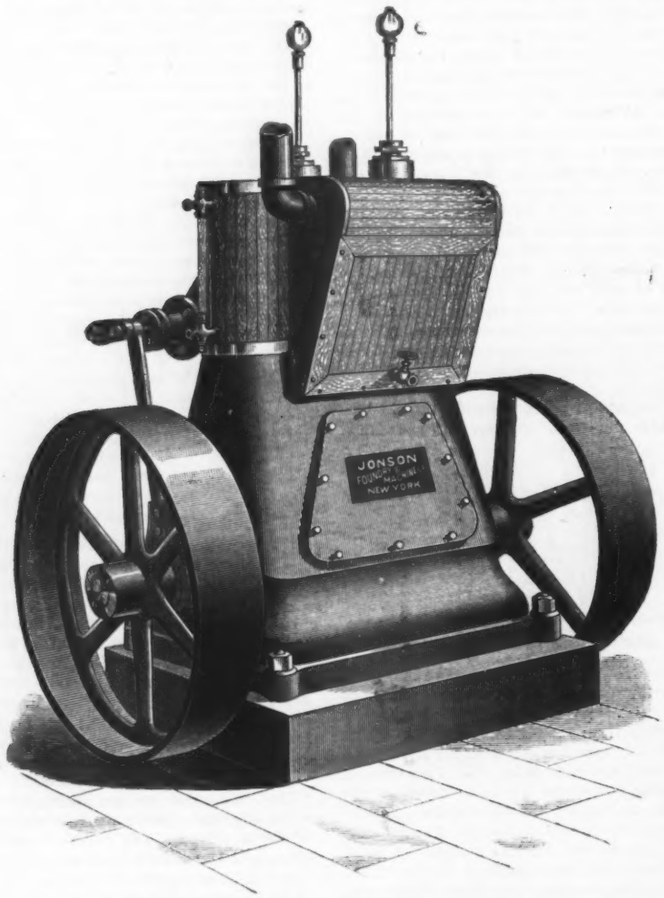
Jonson's Patent Balanced Compound Engine.

This engine is of the trunk type and consists virtually of four half cylinders, with cranks set opposite or at 180°, forming in fact an equivalent for the ordinary high and low pressure cylinder, the area of the annular space between the trunk and the low pressure or compound cylinder being equal to that of the high-pressure cylinder. Thus in the engine in the accompanying cut, the compound cylinder being 12¼ ins. diameter, the trunk 9⅝ ins. scant, the difference in areas 122. 72 — 72.72 = 50, or nearly 8 sq. ins., making this engine 8 in. × 12½ in. × 10. in. stroke. Steam is exhausted from the high pressure end of each cylinder to the upper or compound end of the same cylinder, so that alternately the high-pressure end of one cylinder and its opposite compound end form a complete half stroke.

Excepting for electric lighting purposes, or for very large sizes where the slide valves are of great area, the high-pressure steam and compound valves are made in the same casting, passing the high-pressure exhaust through ports in the valve to the low-pressure end; and by giving the steam, compound, and exhaust valves a definite lead, as determined by practice, both cylinders work in unison. But the two valves being in the same casting, and driven by a single eccentric, or in the case of the marine engine by two eccentrics and the ordinary link motion, any change in this motion, as in using an automatic cut-off, affects the compound and exhaust as well as the live steam; therefore, for this purpose an independent steam valve is preferable, as shown in the cut. On marine engines, the ordinary adjustable cut-off is used.

The advantages claimed for this type of engine are compactness, freedom from vibration, very low center of gravity, and the fact that all the moving parts are exact reproductions of each other. It is mechanically perfectly balanced and can be run at a very high rate of speed, making it especially valuable for electric lighting.

In the accompanying cuts the automatic fly-wheel governor is omitted, as this is not an essential feature of this engine, and is well understood. This engine is manufactured by the Jonson Foundry & Machine Co., of New York, and a marine engine or this type, of 275 H. P., is now being built for the United States Government.



Balanced Compound Engine; General View.

Should a City or Town provide Meters at its own Cost to Consumers of Water?*

The question to which my attention is drawn is one of various opinions, therefore I can only speak of the experience that has come under my personal observation. At the completion of our works in September, 1879, it was voted that hereafter meters be put in at the expense of the town in all cases where the consumer had over two faucets, except where a consumer desired a larger size than the commissioners deemed necessary, in which case the price of an ordinary sized meter would be deducted and the balance of the cost of the larger meter be paid by the consumer. I believe Pawtucket was the first town to adopt that system in this country. A division of the Pawtucket works known as the Central Falls Fire District, adopted the same rules the following year. This ruling seems to have met with general favor, and the number of meter takers has rapidly increased since. Our minimum price is $10 in advance for all meters, allowing them to use 33,333 gallons, thus enabling the mechanic or laboring man, who owns a little home, or a capitalist, who builds and rents tenements, to have all of the luxuries of the rich man in his mansion in the use of water, and the result is that the average amount received is about $16, a year for that class of meters, and under that system the works became popular with that class of consumers. I therefore maintain that it is desirable for any city or town to furnish the aforesaid parties on as reasonable terms as can be done, because it stimulates them to cleanliness, (which is next to godliness) and the sanitary results speak volumes in defence. Of course I can see that where private corporations have charge of the city or town, they have no particular interest in the aforesaid results, as representatives of the same have expressed themselves in previous discussions, and yet I am led to believe that the revenue received from the small takers is of minor importance to that of the manufactory, mechanical or hydrant rental, which is received by all private corporations. You all know that if any corporation had to depend entirely on family supply for their revenue, they would not invest their money in that town or city. I therefore came to the conclusion that the small difference received between faucet and meter rates is not paramount to the good results which will be produced by the good will of the citizens. Corporations know the animosity that always exists against them in a city or town where they do not show a liberal disposition.

I am reminded that at my early connection with water-works, I had occasion to advocate the use of meters and the supplying of the same by the city or town; and let me say here, I mean only the family meter, or its equivalent, when larger ones are required.

In discussing the subject with some superintendents, I was informed that they did not care how much water was used; they could afford to pump it, as their coal only cost $2.50 per ton delivered. I thought to myself, What would be the capacity of their pumping plant within a few years at that rate? The same parties have put in larger engines since, and now recommend more, or putting on meters and making a house to house inspection to stop the waste. Another superintendent said he did not care how much water was wasted, as he had just as soon have it run through the faucets as over the dam. He had the gravity plan and quite a long distance to convey his water. The result I predicted was he would lose head by the friction on the pipe, which has been partially demonstrated since. I might enumerate many such incidents, but time forbids. I maintain that you cannot afford to waste water under any circumstances, and especially where you have to pump it.

Now, what is the remedy for stopping the waste? I say most emphatically, the meter system. My experience is that we receive revenue enough over and above what we would receive "by the use of meters," caused by poor plumbing, leaking in water-closets, or the cock and ball in tanks, and other ways that are unknown, to pay for *all* new meters supplied, and I believe that the experience of others will endorse my statement. By referring to a paper read at Cincinnati, April 16, 1884, in the discussion on the subject of meters, there were different experiences related which would have a bearing on this subject. There is but one case that I can see where meters are useless, and that is where you have an unlimited supply on the gravity plan, and that situated close to your city or town where the expense will be comparatively small to put in mains large enough to reduce the friction in the pipe, with sewerage sufficient to deliver the same; then you could allow them to use and waste all the water they wanted to. I sometimes think I should like to see one case, if it could be found, where a works could be established, and the water-wasters that can be found in all cities moved there and allowed to enjoy their wasteful propensities to the full. What a record we should see! and I believe that the curiosity to know what the result might be, would induce the superintendents of the country to join together and procure a meter to be placed on the main supply.

The waste of water is getting to be a serious question, and especially where it has to be pumped into reservoirs and settled and then repumped into the city, or where they have an unlimited supply and are allowing an unrestricted use of water.

I believe it costs less to supply and maintain meters than it does to erect pumping engines and storage reservoirs. The cost of coal, while it enters into the expense account, has its bearing where water is legitimately used and paid for; but where it is wasted it has a further value, as it carries with it the cost of machinery, stations, pipe lines and new sources of supply, besides the wear and tear, the continuous expense of pumping, and the pay of the engineers and firemen. I would like to ask the experience of superintendents as to the effect extreme cold weather has upon the daily consumption of water. I have about 2 000 services unmetered, with from one to two faucets. Now my experience is, let cold nights come, and we are obliged to pump 500,000 gallons more per day to supply the waste from these services alone, for the others are metered and we receive pay for the water. Please make a comparative estimate from your own situation.

We find another trouble with unmetered services; the faucets will leak and remain so until the inspector comes around, then they will be stopped; but where the meter is placed they do not wait for the inspector, because its costs money. Another result we get is, where we find services are *excessively* used, where there are only two faucets, we put a meter on, and invariably we receive a revenue over and above the faucet rates, which will pay for the meter, sometimes the first year and sometimes in two years, but invariably we get paid for the meter. And yet the person is perfectly satisfied

* A paper read by EDWIN DARLING, Supt. of the Pawtucket Water-Works, at the annual meeting of the American Water-Works Association at Louisville, Ky., April 16-18, 1889.

when you show him he is necessarily using the water and at the rate of one cent per barrel. It must be borne in mind that the unmetered service *can* and *does* waste more than the metered, even where they are willing to pay for the waste, as they have no restriction except the inspection. The rules may provide for penalties; but what do consumers care when the inspector's back is turned, and what do they care whether the faucet is shut or not? It costs no more. Show me a city or town where they do not use meters "with but few exceptions, and where they have a systematic house to house inspection," and I will show you pumping plants in excess of what ought to be, and a per capita of consumption that will astonish you. I do not pretend to say that the meter will apply to every situation, but I do mean to say it will apply to a large majority.

The meter system produces good results, as it shows to each and every one that they are used alike, and gives them equal privileges at the same cost. In fact they pay their bills seemingly with pleasure, and I may add that during the collections of the past ten years, and receiving over $600,000, I have never had a single one come into the office with a grievance who did not, after explanation, pay his bill and leave apparently satisfied.

In regard to the repairs of meters, I may say we remain practically with the same proportional results as in my statement made in 1884.

As a result of the meter system in Pawtucket, in 1879 our works cost over $600,000, and the revenue was $16,000 for that year. It was thought by many that we could never pay the interest on the debt, but in 1882 the revenue was $27,000, and the Commissioners reported they were able to pay all interest and maintenance accounts. Since 1879 we have increased the debt from year to year by building necessary dams, reservoirs, and pumping stations, so that it now amounts to about $1,550,000, and we have paid all maintenance and interest accounts on the same, and passed into the sinking fund and construction account $44,000 beside. Our works are now fitted to do the necessary work for many years to come without any large expenditure of money, and an increase of revenue is sure to follow.

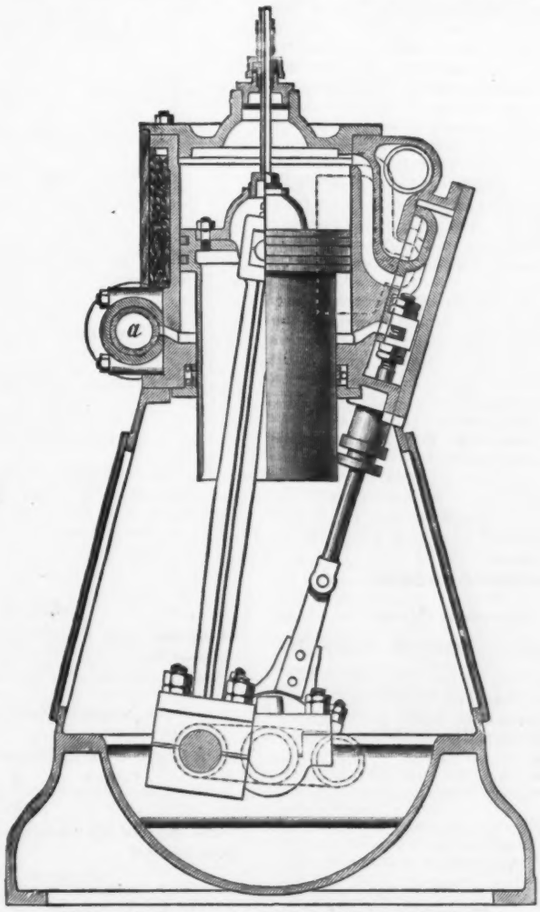
You also must remember that our rates are as low or lower than the majority of other water-works, under similar conditions. Our revenue for the past year was $95,000, using less than 4,000,000 gallons per day and supplying a population of about 55,000, with a consumption of 65 per cent. for purposes other than family use.

I desire to say a few words in regard to the correctness of meters. We all know that the consumers of water, in case their bills overrun, doubt the meter's accuracy. Now in an experience of ten years I have never seen an instance where I had occasion to think that the meter had registered against the consumer, but on the other hand I know that there are cases where the meter will pass water and not register. This subject was very generally discussed in 1884, at Cincinnati, and our late associate, Mr. W. C. STRIPE, offered the following resolution:

"*Resolved*, That it is the opinion of this Association that water meters do generally measure water correctly and that where they make mistakes it is invariably in favor of the consumer."

Since that time I have had experiences which verify that opinion, and I make it a rule that where the consumer doubts the correctness of his meter, he shall devote his personal attention to seeing the meter put under test, and verify the correctness himself. I have never yet had a case where he did not go away perfectly satisfied that the meter could not register against him, and I may say that quite a number have availed themselves of this opportunity.

In conclusion, I would say that from my past experience of ten years in the use of meters in all forms (to which I attribute a large proportion of our success) I do believe that it is advisable for cities, towns, or corporations, as a rule, to furnish and maintain what would be called a family meter at their expense (except in case of frost or abuse), and charge it to the construction or maintenance account.



Balanced Compound Engine; Sectional View.

THE NEW DRY-DOCK, just formally opened at Newport News, Va., by docking the monitor *Puritan*, is 600 ft. long, 130 ft. wide at top and 50 ft. at the bottom, has an entrance width of 93 ft. and draft over sill of 25 ft.

THE MICHIGAN CENTRAL is running a car between Detroit and Chicago lit by electricity from storage batteries, to experiment upon the cost and practicability of such service.

The Washington Aqueduct Tunnel.

Congress, on Oct. 19, 1888, ordered the suspension of all work on the Washington Aqueduct tunnel and appointed a joint special committee of six members, three of the Senate and three of the House, who were to conduct a thorough investigation into the character and condition of work on the tunnel. This committee met and organized on Oct. 29, 1888, with Hon. GEORGE F. EDMUNDS, as Chairman. In making their report to Congress on Feb. 26, 1889, the committee review the entire situation, which may be summarized as follows:

The present water supply for Washington and Georgetown was completed in 1859. The water is taken from the Great Falls of the Potomac, about sixteen miles above Washington, and conveyed partly in tunnel but mainly by a surface conduit first to a receiving reservoir about six miles above the city, and then to a distributing reservoir a mile above Georgetown. Iron pipes convey the water from the latter reservoir to Georgetown and Washington. The supply at the Great Falls is deemed adequate for a long period and the aqueduct to the receiving reservoir is of sufficient capacity to meet the consumption for many years to come. But several years ago the supply of water in the higher parts of the city was found to be entirely inadequate, and various plans for relief were submitted to Congress. By an Act of July 15, 1882, the Secretary of War was directed to have surveys made for the extension of the Washington aqueduct to the high ground north of Washington, and for the construction of a reservoir at that point of not less than 300,000,000 galls. capacity. Under this Act the work was inaugurated that resulted in the present tunnel, though Congress had not provided for such a tunnel, says the Special Committee.

When the matter was being considered by the engineers of the army, the principal problem involved was the best method of crossing the deep valley of Rock Creek; and it was suggested that this could best be done by bringing the aqueduct to the west side of the valley, and then sinking a shaft to a proper depth below the bed of Rock Creek, and tunneling eastward to another shaft rising to a point suitable for extending the aqueduct to the eastern terminus. It appears then to have been decided upon by the engineer in charge that if it was a good plan to tunnel under Rock Creek, instead of using syphon pipes or a bridge, it would be equally advantageous to tunnel the whole distance and rise through a shaft at the eastern reservoir. This radical change from previously considered plans was reported to the Chief of Engineers by Major G. J. LYDECKER, Engineer-in-charge, under date of Oct. 5, 1882. In his letter Major LYDECKER reported this tunnel plan as, in his judgment, the best and most economical, and the one that could be carried out in the shortest time. He believed the tunnel could be driven through solid rock in its entire length, and that it would avoid the heavy land damages required for a surface conduit.

In July, 1883, Gen. H. G. WRIGHT, Chief of Engineers, recommended that the tunnel plan be finally adopted; though the committee say that the evidence proves that, up to the time of this recommendation, no borings or examination of the rock on the line of the tunnel had been made, and the opinion as to the character of the rock to be excavated was based solely upon what was found in one trial shaft at the eastern end, the appearance of surface rock in the valley, and some private wells in the neighborhood. Gen. WRIGHT says that he approved the plan because he was satisfied the rock was good and the cost not above other methods. The plan thus established called for a tunnel passing 85 ft. below the bed of Rock Creek. This was finally increased to 150 ft. in searching for good rock, which after all was not found.

Accordingly, on Aug. 29, 1883, proposals for bids were issued, and seven bids were received. The contract was finally awarded to Messrs. Beckwith & Quackenbush, though there were two lower bids, those of J. H. Dewees & Co. and Eugene Robinson. The contract was signed on Oct. 29, 1883, and by its terms required that the work should be completed by June 30, 1885. The tunnel itself was to be 20,715 ft. long, with five working shafts and at an average depth of 150 ft. below the surface. The estimated cost was $545,031, though an additional appropriation of $395,000 was asked for and obtained in 1885 to

meet a rise in prices of material and labor and to provide for certain works not contemplated originally. The tunnel was "holed" by June 30, 1887. As a result of the experience gained by this time, the Board of Engineers concluded that the exclusive use of concrete for lining was impracticable and it endorsed the use of a brick arch with rubble backing laid in cement mortar, or fine concrete backing. No provision had been made for rubble masonry in the original contract, and a supplemental contract was drawn up in October, 1886, to meet this enforced change from dry stone packing to masonry.

On June 30, 1887, when the tunnel was "holed," the summary of all appropriations up to that time amounted to $999,534.55, with only $123,837.70 unexpended. At that date the total estimated cost of the completed tunnel was $1,181,582.55, owing to the fact that, instead of about one-half of the tunnel requiring lining, as figured in 1885, nearly the whole length required this protection, and that at the increased cost of rubble masonry, instead of dry packing behind the lining. Congress did not make any further appropriation, and in the fall of 1887 the work was temporarily abandoned, and the tunnel allowed to fill with water. It remained flooded until after March 30, 1888, when Congress made a further appropriation of $355,000, and required in connection with it that the tunnel be completed by Nov. 1, 1888. Under the authority of Congress a supplemental contract was then made with the old contractors, providing for the new class of work called for in brick arches and rubble masonry side walls.

The work then proceeded under the following organization: Major LYDECKER was in charge of the whole aqueduct system, including the tunnel; Lieut. TOWNSEND was in immediate charge of work after May 4, 1887; the contractors were Beckwith & Quackenbush; sub-contractors, Emory & Brennan and Brennan & Palmer successively. These sub-contractors undertook, with Beckwith & Quackenbush, to do the work of lining and backing for a certain sum, the main contractors supplying all the material. In the fall of 1888, some of the workmen employed reported that this work was being improperly done, and this report finally led to a suspension of work and the appointment of the Joint Special Committee of Congress, the report of which is here used.

The committee deemed it important that the investigation should be entirely separated from the War Department and from any engineer officers of the army, and to this end secured the services of three expert civil engineers of large experience and the highest character and capacity, and gave these gentlemen written instructions as to the nature and extent of their investigations. The board of experts selected was made up of Mr. JOSEPH M. WILSON, Mr. HENRY FLAD, and Mr. FREDERIC GRAFF, two of them past presidents and all of them prominent members of the American Society of Civil Engineers.

From the report of this board of engineers, and from the testimony taken, the Congress Committee reports that beyond all question substantially the whole and every part of the lining of the tunnel is "absolutely and enormously defective," and, further, that it is scarcely too much to say that there is hardly any continuous ten feet in the whole lining where the backing, particularly over the arch, is not either absolutely wanting, or only partly filled in, or when fully filled in so badly constructed as to make the whole lining unreliable and entirely worthless. The committee says that it appears from the testimony that during the progress of the lining work several of the Government inspectors received, under false names, various sums of money from the contractors, with the connivance of the time-keeper of the contractors. Mr. QUACKENBUSH, the contractor in charge, testifies that he had no knowledge of these transactions, and Major LYDECKER and Lieut. TOWNSEND also testify to the same effect.

The committee exonerates Major LYDECKER and Lieut. TOWNSEND from any corrupt practice in the matter or personal knowledge of the money paid to inspectors. They say, however, that the fact remains, notwithstanding the responsibility and the duty of vigilant superintendence and watchfulness on their part, and the contracting duty of the contractors, that thousands of feet of this lining, occupying six months in its construction, were systematically put in in such a manner as to defraud the Government, and were absolutely worthless for the purposes of a tunnel carrying water under great pressure. In view of the evidence, the committee feels compelled to charge the officers responsible for the work, as well as the Chief Government Inspector, Mr. KIRLIN, with great negligence in the discharge of their duties.

To Aug. 31, 1888, the contractors were regularly paid for the work as it progressed to the full extent they would have been entitled to, had the work been properly done, less 10 per cent. reservation provided for in the contract. The account with the contractors stands as follows:

Due Beckwith & Quackenbush for work in September and October, 1888	$30,134.89
Retained percentage on last extension	10,605.65
Retained percentage on contract prior to May 18, 1888	13,814.03
Estimated sum now due for excavation actually completed	38,500.00
Total	$102,053.57

When the supplemental contract of May 8, 1888, was made, no new bond was taken from the contractors, the engineer in charge supposing that the original bond, under the contract of 1883, was still valid. This view is open to grave consideration.

The committee estimate from the report of the experts that it will probably cost $900,000 to put the tunnel in a condition to carry water from one reservoir to the other, and even then they think there would be danger: 1. Of water percolating through the lining outward. 2. Of injury to property from this percolation. 3. Of accident or emptying of the reservoir. 4. Of extreme difficulty of repair in case of accident. 5. Of extreme difficulty of cleaning the tunnel.

In conclusion, the committee reports that, even when another large sum is expended upon the tunnel, its future is a problem that nothing but time and experience can demonstrate for good or ill. And they substantially advise the entire abandonment of the tunnel plan and the substitution for it either of a line of 48-in. cast-iron pipes or a substantially built gravity conduit. They have submitted to Congress two amendments, one enabling the Secretary of War to lay one 48-in. main, and the other providing for a survey for a surface conduit. The report of the board of experts contains much interesting matter, which will be given in a later issue.

CORRESPONDENCE.

A Transition Curve.

BY PROF. W. H. ECHOLS, MISSOURI SCHOOL OF MINES.

While we are waiting for Mr. WELLINGTON'S Field Book to appear, in which we are promised a settlement of the transition curve affair, it may prove of interest to regard that matter in the light in which it is done below.

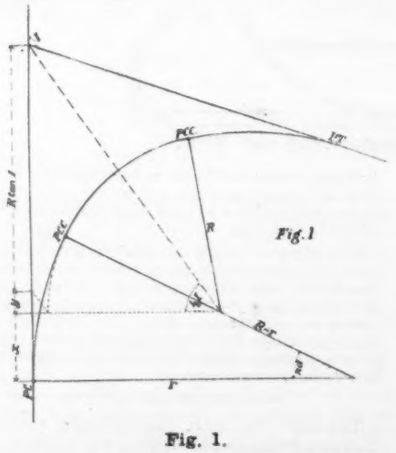


Fig. 1.

The transition curve must afford an easy chance of curvature from the tangent to the curve. It is also desirable that it should be located in the beginning with the transit and as easily as can be done a simple circular curve. The point of curve must be as easily obtained as that of a simple curve, and the location differ as little as may be from that which it would occupy should no transition curve be compounded with it.

I take the following problem to be the solution of the question practically, and the ease with which the numerical work may be accomplished, together with the simple field-work necessary, to be the desired object to be attained.

To pass from the tangent to a D° *curve by* n *stations of a* d° *curve.* (Fig. 1.)

The ordinary notations are employed and the figure explains itself.

For the tangent distance we have

$$T = R \tan \tfrac{1}{2} I + x + y$$

where from the figure

$$x = (r - R) \sin nd, = 100\, n \frac{D-d}{D}.$$

Likewise

$$y = (r - R)(1 - \cos nd) \tan \tfrac{1}{2} I,$$
$$= \tfrac{1}{2} \frac{D-d}{D} n^2 d \tan \tfrac{1}{2} I.$$

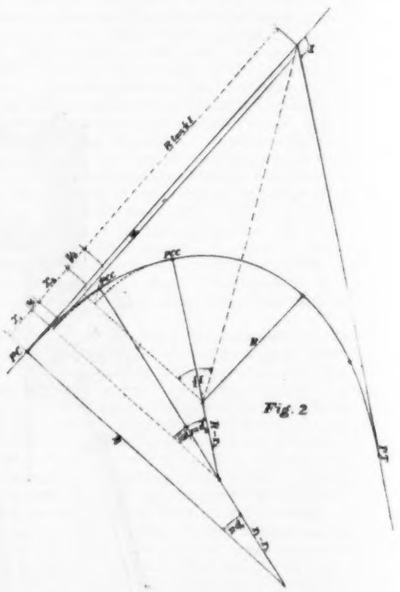


Fig. 2.

where the usual values in circular measure have replaced the *sin* and *cos* of the small angle *nd*.

The tangent therefore becomes

$$T = \left(R + \tfrac{1}{24} \frac{D-d}{D} n^2 d\right) \tan \tfrac{1}{2} I + 100\, n \frac{D-d}{D}$$

The length of the whole curve in stations is

$$L = \frac{I - 2nd}{D} + 2n = \frac{I}{D} + 2n \frac{D-d}{D}.$$

The effect of the transition is to move the curve in an amount

$$\tfrac{1}{24} \frac{(D-d)\, n^2 d}{D} \sec \tfrac{1}{2} I.$$

These results, being general, are much simplified for particular cases, Thus for $n = 2$, $d = 2$.

$$T = \left(\frac{5716}{D} + 7\right) \tan \tfrac{1}{2} I + 200 \frac{D-2}{D},$$
$$L = \frac{I}{D} + 4 \frac{D-2}{D}.$$

And will be equally simple for any other values of n and d which would be selected for a transition curve.

It may be urged that such a transition does not afford a sufficiently gradual change of curvature in which case consider the following extension of the same problem, which in its final results presents some good points. While the reduction of the formulæ are somewhat more lengthy, yet the final result is as simple as the one above; indeed, it is almost identical with it.

To pass from the tangents to a D° *curve by* n *stations of a* d_1°, *and* m *stations of a* d_2°, *curve.* (Fig. 2.)

Here as before the figure is self-explanatory, and we have for the tangent distance

$$T = R \tan \tfrac{1}{2} I + x_1 + y_1 + x_2 + y_2.$$

where we have

$$x_1 = (r_2 - r_1)\sin nd_1,$$
$$= 100\, n \frac{d_2 - d_1}{d_2},$$
$$x_2 = (r_2 - R)\sin(md_2 + nd_1),$$
$$= 100 \frac{D - d_2}{D\, d_2}(nd_1 + md_2.)$$
$$y_1 = (r_1 - r_2)(1 - \cos nd_1)\tan \tfrac{1}{2} I,$$
$$= \tfrac{1}{2} \frac{d_2 - d_1}{d_2} n^2 d_1 \tan \tfrac{1}{2} I.$$
$$y_2 = (r_2 - R)[1 - \cos(nd_1 + md_2)]\tan \tfrac{1}{2} I$$
$$= \tfrac{1}{2} \frac{D - d_2}{D d_2}(nd_1 + md_2)^2 \tan \tfrac{1}{2} I$$

in which results as before the *cir-meas* has replaced the sin, and $1 - \frac{1}{2}$ (*cir-meas*^{2}) the cos of the small angles nd_1 and $(nd_1 + md_2)$.

We can if we choose write

$$y_1 + y_2 = \frac{7}{8}\left\{ n^2 d_1 + m^2 d_2 + 2mn d_1 - \frac{1}{D} (md_2 + nd_1)^2 \right\} \tan \frac{1}{2} I,$$

and

$$x_1 + x_2 = 100\left[m + n - \frac{nd_1 + md_2}{D} \right].$$

The length of the curve in stations is

$$L = \frac{1}{D}\left[I - 2(nd_1 + md_2) \right] + 2(m + n),$$
$$= \frac{I}{D} + 2\frac{m(D - d_2) + n(D - d_1)}{D}$$

These general formulæ, which from the nature

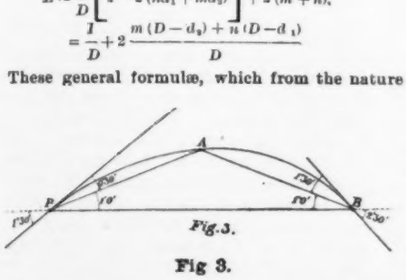


Fig.3.

Fig 3.

of the problem necessarily appear complicated, are in any particular case reduced to the desired degree of simplicity; for example, let it be decided to always approach a curve (whose curvature is 3° or greater) from the tangents by 1 station of a 1° curve, followed by 1 station of a 3° curve. Such a transition I take to leave nothing further to be desired in the practical view of the subject, provided the numerical computation and the field-work is of a sufficiently simple nature, and it is believed that the following reaches that desideratum.

Substituting these selected values, $n = m = d_1 = 1, d_2 = 3$, we have for the tangent

$$T = \left(R + \frac{21}{4} - \frac{14}{D} \right) \tan \tfrac{1}{2} I + 200 \frac{D - 2}{D}$$

or in more compact shape

$$T = \left(\frac{5716}{D} + 5.2 \right) \tan \tfrac{1}{2} I + 200 \frac{D - 2}{D}.$$

The length of curve is

$$L = \frac{I}{D} + 4 \frac{D - 2}{D}.$$

The effect of transition is to move the mid-point of curve

$$\left(\frac{21}{4} - \frac{14}{D} \right) \sec \tfrac{1}{2} I$$

further from the intersection of the tangents than it would be for a simple $D°$ curve.

Thus the numerical work of a transition curve of two stations of a 1° and 3° curve is identically that of two stations of a 2° curve. If the fieldwork is equally simple, then the former transition is preferable to the latter. That this is the case will be readily recognized, for it is hardly necessary to mention that the compound transition curve of 1 sta. of 1°, and 1 sta. of 3° can be run in from either end so that the instrument need only be set up at the beginning and end of the transition. The figure (Fig. 3) shows the necessary deflections for setting points and recovering tangents to be as follows:

The instrument at P, a deflection of $0°\,30'$ sets the first 100′ point A, and an additional deflection of 1° 0′ sets the end of the 3° curve B. The chord from this point to P makes 2° 30′ with the tangent at B.

In running backward from B, the points A and P are set by deflections of 1° 30′ and 1° 0′ additional respectively, while the terminal tangent is recovered by deflecting 1° 30′ from $P\,B$.

While in each case of the general problems here presented, a particular case of transition curve has been selected, to be used in illustration any others may be chosen instead should they be preferred; in any case, however, the results will not differ so far as numerical work is concerned, and the field-work will be equally simple.

These simple circular arcs may be chosen so as to occupy the same location as any arithmetical or logarithmic spiral or simple or semi-cubic parabolæ which might be selected; and surely no transitman can find fault with the very slight additional amount of numerical and field-work necessary to locate them.

[We do not think this method calculated to fulfil all the requirements for a system of transition curves, nor to replace such a system; but the method of analysis is ingenious and the formulæ simple and likely to be useful.—ED. ENG. NEWS.

The Memphis Sewerage System.

NEW YORK, April 22, 1889.

TO THE EDITOR OF ENGINEERING NEWS:

Your late issue contains a letter from Col. GEO. E. WARING, Jr., in which he makes several statements, upon which I trust you will allow me to comment.

He remarks that after my visit to Memphis (see my letter in ENGINEERING NEWS, Jan. 26, 1884), I had found the sewerage works so far changed as to be substantially another system from that which he built. The magnitude of this change will appear from my statement that the difference between the Waring system *as patentable* and the English separate system was "almost infinitesimal." If the rainwater from even a single roof is admitted, its patent charm is at once broken. As some rainwater did enter the sewers, I maintained it was no longer the patented system.

In quoting that I said the Memphis system was "as good as any city or town suitable for its application could wish it to be," he should have continued the quotation, "yet no better than it would have been had it been built in exact conformity with English practice."

The reason for its working satisfactorily I declared to be due to the intelligent management and continually necessary vigilance of the local officers, and not to any novel features of the design. Had it been built upon better principles, much less vigilance and expense for maintenance would have been required, as proved by other localities, and I have therefore never in any particular modeled my own designs after it.

He says further, that an examination showed my communication to ENGINEERING NEWS, referred to above, "to be essentially untrue." I have carefully looked over it, and find that everything I wrote is strictly correct, except one word, which was either a misprint or an error of writing. I say "stoppages have occurred to an extent which made it necessary to build manholes every few hundred feet." Instead of *necessary*, it should have read *desirable*. They were continually adding manholes, and during my visit expressed the wish to have them at every intersection.

Col. WARING states that rainwater was never substantially excluded from sewers until it was done at Memphis. Ainwick, in England, with a population of 7,000, and 1,400 water closets, has had an outlet sewer 18 ins. diameter, with a grade of 1:400, since about 1856. Tottenham in 1852 was sewered by an 18-in. sewer, 1:1000, with a population of about 10,000. An 18-in. sewer for so large a population, I should say substantially excluded rainwater.

Reading, Oxford, and a number of other towns, likewise excluded it as far as it was considered practicable.

Regarding a statement in the last paragraph of Col. WARING'S communication, I desire from a professional point of view to take a decided exception. He states that the "Memphis system, essentially unchanged, is now in active operation in between forty and fifty towns in the United States." Elsewhere he has named some of these fifty towns, and among them a number of which other engineers, including myself, have made the designs. He has a right to claim only such systems as he designed himself, or where his patent is valid, and not those which have been based upon the English practice. As far as I am personally concerned, I have in no respect modeled any system of sewers after Waring's patents, and have therefore had the satisfaction of avoiding the large number of stoppages and the difficulty of removing them, which are reported from Memphis. As substantially outlined in RAWLINSON'S "Suggestions," and based upon knowledge which has been gathered in England by experience in sanitary works for many years, the essential features of the Separate System of Sewerage concisely stated, and as recognized in England before 1880 (when I believe his patent was obtained), are:

1. Exclusion of rainwater as far as practicable, even "every drop of roof and surface water," where this can be accomplished.

2. Sewer pipes laid perfectly straight in line and grade between point of access, to allow of complete inspection.

3. Manholes or lampholes at every change of line or grade, which change is made by a smoothly curved channel within such holes.

4. Size of sewers proportioned to carry not less than three times, better six times, the average daily water-supply. Size of public sewers to be at least 9-in. diameter.

5. Flushing channels at heads of sewers and drains. Automatic syphons or other appliances.

6. Ventilation through perforated manhole covers, at least once every hundred yards.

No system of sewers built on the above principles is rightly called the Memphis or the Waring system.

RUDOLPH HERING

Compasses with Micrometer Adjustment.

PHILADELPHIA, Pa., April 23, 1889.

TO THE EDITOR OF ENGINEERING NEWS:

We are surprised to note in your issue of the 20th that any one should take exception to the article on "Compasses with Micrometer Adjustment" without having first made a careful investigation of facts. The idea of placing the hair-spring on pen and pencil compasses is not a new one, and occurred to us years before it was actually manufactured, and we made one for our personal use years before the date mentioned by complainants. This instrument was seen by draughtsmen and engineers who visited our factory, and they wanted similar instruments; we then concluded to place it on the market. The advantage of using the hair-spring with pen or pencil might occur to any one using the ordinary hair spring dividers, and only a few weeks ago we received a communication from an engineer which reads, "I have often wondered why the hair-spring was not applied to pen and pencil compasses long ago." We regret that any one should claim through your worthy columns that we are imitators; we leave it to the engineering profession and draughtsmen generally who know us as originators. We also wish to make the following statement:

At the time we placed this instrument on the market, we did not know that any similar instrument was handled by the complainants or any other dealers. We at no time have had in our office or factory any instrument having this attachment to use with pen or pencil, nor have we ever seen or handled such an instrument. After a careful examination of catalogue mentioned, we fail to find any description of such an instrument; the number instrument mentioned is an ordinary hair-spring divider, but looking further, we find an instrument which might be somewhat similar, but illustration fails to show it, and while we do not seek the glory which our competitor disdains, we accept with pleasure whatever credit the profession may deem due us for our well-recognized improvements in drawing instruments.

Very respectfully,
THEODORE ALTENEDER.

A CORRECTION.

MR. JOHN W. HILL asks us to make the following corrections in his "Tables for Power of Compound Pumping Engines," published in our issue of April 27:—In Table *C*, the first line should read "Diam. L. P. cyl." In Table *B*, main heading should be repeated for middle column. In table of ratios of expansion at foot of last column, on page 377, for *D*, read *S* = Stroke of both pistons, etc., and in the last formula in the article, for *H*, read $W =$

$$(Hyp.\ Log.\ of\ E_3 + 1)\left(\frac{r + c}{4}\right)$$

Notes, Queries and Answers.

A. W. S. There is practically no difference between naphtha and gasoline, naphtha being a general term which includes gasoline. Technically, however, there has been a subdivision of the several volatile products of crude petroleum, in order of their specific gravity and volatility, as follows:

	Specific gravity.	*Boiling point.*
Rhigoline	.625	65° F.
Gasoline	.665	150°
C Naphtha	.708	180°
B "	.724	220°
A "	.742	300°
Kerosene	.804	350°
Mineral sperm oil	.847	400°
Neutral lubricating oil	.893	575°
Paraffine wax	.848	....

Gasoline, in the technical sense, is therefore considerably more volatile and dangerous than naphtha proper. Rhigoline is the lightest of all known fluids, and gives a mercury bulb the temperature of —19° Fahr. in 20 seconds.

J. I. W., Boston, Mass. We expect shortly to republish the hydraulic papers of Mr. E. SHERMAN GOULD in pamphlet form.

ENGINEERING NEWS

AND AMERICAN RAILWAY JOURNAL

Published Weekly at Tribune Building, New York.

VOL. XXI. Saturday, May 4, 1889.

D. McN. STAUFFER, A. M. WELLINGTON — *Editors.*

CHARLES W. BAKER, E. E. R. TRATMAN, M. N. BAKER — *Associate Editors.*

GEO. H. FROST — *Business Manager.*

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Drawings for publication *should preferably be in plain black and white, considerably larger than they are expected to appear, with letters and figures in pencil only, all lines clean and bold.*

Coming Technical Meetings.

Engineers' Club, Philadelphia, Pa.—Regular meeting, May 4. Secy., Howard Murphy, 1122 Girard St.

Engineers' Club of Kansas City, Mo.—Regular meeting, May 6. "Foundations for the Llimfjord Bridge," Otto F. Sonne. Secy., Kenneth Allen, 310 Baird Building.

New England Railway Club, Boston, Mass.—Regular meeting, May 8. "Interchange of Freight Cars" and "Increasing Size of Car Axles." Boston & Albany passenger station.

Civil Engineers' Club of Cleveland, O.—Regular meeting, May 14. Report on Applied Science. Secy., James Ritchie, Case Library Rooms.

American Society of Mechanical Engineers.—The annual meeting will be held at Erie, Pa., May 14, 15 and 16. Secy., F. Hutton, 64 Madison Ave., New York City.

Boston Society of Civil Engineers.—Regular meeting, May 15. "High Service System of the Boston Water-Works." J. A. Gould Jr.; "Measurements of Flow of Water at the Boston Water-Works," C. E. Haberstroh. Secy., S. E. Tinkham, City Hall.

American Society of Civil Engineers, New York.—Regular meeting, May 15. Secy., John Bogart, 127 E. 23d St.

Engineers' Club of St. Louis, Mo.—Regular meeting, May 15. "Trussing a Building against Wind Pressure," Prof. J. B. Johnson; "Fire Proof Flooring," P. M. Bruner. Secy., Wm. H. Bryan, 709 Market St.

New York Railway Club.—Next meeting, May 16. Rooms, 113 Liberty St., New York City.

Engineers' Society of Western Pennsylvania, Pittsburg, Pa.—Regular meeting, May 21. Secy., S. M. Wickersham, Penn Bldg.

Denver Society of Civil .—Regular meeting, June 4. Sec., W. W. Follett, Tremont Block.

Western Society of Engineers, Chicago, Ill.—Regular meeting, June 5. Secy., John W. Weston, Gaff Building.

Association of Civil Engineers, Dallas, Tex.—Regular meeting, June 7. Secy., E. K. Smoot, 15 No. Jefferson St.

We have received recently, from the Isthmus of Panama, a specimen calculated to do a trackman's heart good,—a lignum-vitae cross-tie which has been in the track of the Panama Railroad *for thirty-five years*, or since the road was first built, the wood being still almost as sound as ever it was. The only rot is where the spikes have been driven in; and as no spike can rationally be expected to last 35 years, even in our climate, it is small matter of surprise that the spike holes are many and large. Several of these holes are still filled with the lower parts of the old spikes (it being almost impossible to extract them) but the other spike-holes are somewhat decayed, and in a peculiar way, the decay being total so far as it goes, and then passing abruptly into perfectly sound wood. It is on account of the impossibility of driving any more spikes into the tie that it was removed, since the main body of it is as sound as ever.

The point of most interest is the cutting of the tie. The rail during 35 years has cut down from the original surface fully 1¼ ins., and this not unequally by gradual tipping over, as is so apt to be the case with ties of softer wood, but by parallel wear, the top of the worn surface being perfectly sound, but strangely depressed below the adjacent wood.

This wood is at least three times as hard as white oak, and five or six times as hard as any of the softer cross-tie woods. It seems to be more absolutely durable against rot than any form of creosoted or treated timber can be expected to be, since 35 years of exposure in that climate is worse than a century here. Yet this great abrasion has taken place in that period; and in view of it, how long can even the best of treated ties be expected to survive in our service? Loaded as heavily as they are, it seems a perfectly legitimate conclusion that if they were so treated as to be absolutely incapable of rot, any softer wood than white oak could not be counted on for more than 8 to 10 years; and in this fact perhaps we have a partial explanation of the reluctance to expend much money for treating ties, which seems to be (and undoubtedly is) so unfortunate.

The lignum-vitae ties cost only $1.50 each delivered at Panama, which is as cheap as there is any rational hope of obtaining metal ties. They could probably be laid down on our sea-coast for not much more than that sum, at least if there were considerable demand, for there are enormous forests of such indestructible hard woods in Central and South America; and if a large demand existed, there would be no lack of men who would make arrangements to fill it.

Now assuming (what we do not think to be the case) that there is a danger of serious scarcity of ordinary tie timber in the eastern United States within the next 10 or 20 years, in what respect does a steel tie promise to be any better than such hard wood ties? It certainly will not be any more durable, for the steel tie is probably not yet made which will stand 35 years of hard service; it certainly will not be smoother or more noiseless; it certainly will not be more easily tamped, nor as easily; and it can hardly be much cheaper, if any. In the far West, where the question of transportation would become serious, metal ties may well have a great advantage; and England is so much further by water from such sources of supply that the natural recourse there is to steel rather than to tropical woods; but before steel ties will be used on a large scale in our Atlantic States, we shall look with some confidence to see non-rotting tropical ties introduced. A tie at $1.50, good for 35 years, is cheaper than one at 65 cts. good for only 7 years. Prices have rarely touched 65 cts. yet, but when they begin to, lignum-vitae, and other like woods, rather than steel, may come to the front.

In reviewing the last report of the Massachusetts State Board of Health, as elsewhere presented, we were most forcibly struck with the thoroughness of the work and the faithful and intelligent manner in which these gentlemen have executed the duties imposed upon them by their office. The report is, in fact, a striking example of the good that can be performed by a State commission that honestly goes about its work, and more than that, knows how such work should be done. The chief and consulting engineers of the Board, and the engineers making the special reports, are men well known to every American engineer. They have had full experience in the several fields of their special investigation, and as a consequence their opinions carry conviction, and it is certain that their duty has been conscientiously and intelligently performed. While the Board itself is a most able one, as its good record sufficiently shows, we understand, upon excellent authority, that to one of its members, Mr. HIRAM F. MILLS, Chairman of the Committee on Water Supply and Sewerage, especial credit is due for the preparation of the report. Though his office is entirely without salary, Mr. MILLS has devoted his time largely to the study of the problems submitted to the Board of which he is a member; and in so doing has, we believe, declined lucrative practice as a consulting engineer, upon the ground that his first duty was to the State and to the State alone. This sacrifice of personal interest to public duty is in striking contrast to the manner in which too many men in this generation interpret the obligations and privileges of an official appointment. Massachusetts in this, as in other cases, has good cause to be proud of its Boards and of its engineers, and of the character of work it receives from their hands, whether in preliminary study or in execution.

The Washington bridge across the Harlem river, in this city, was informally opened on last Tuesday by simply removing the barriers that have for some time been the only obstruction to travel. The day was appropriate for handing over to the waiting public an exceedingly handsome and useful structure, and though all formal ceremonies were lacking, the bridge will speak for itself long after the congratulatory speeches usual on such occasions would be forgotten. Comparatively few, even of the residents of New York, realize that this bridge, in its site, its 500-ft. arch spans, its well-designed architectural features, and its most admirable and excellent workmanship, is one of the very best and most impressive bridge structures in the United States. And more than this, it has been carried on quietly and without press criticism, so that only those who daily passed under it on the Hudson River road seemed even to know of its growth and final completion. It is a creditable and enduring monument to engineering skill and to the judgment and good taste of a commission that permitted the engineers to twist a most unpromising original project into its present very satisfactory shape. How the parties are to be dealt with who contracted to build one thing and turned out something else much more elaborate and expensive, is a question the Commission must decide. But no one will regret the increase from the original estimated cost, even if it be doubled. An ugly bridge on such an unsurpassed natural site would be too dear at any figure.

The burning of the Pennsylvania ferryboat, *New Brunswick*, in the North River recently, ought to direct attention to the folly of constructing our ferry and river steamers of materials as inflammable as tinder. The facts of the accident were briefly as follows: The boat was in the slip at Jersey City, just ready to leave for New York. There were not more than a hundred passengers on board, and it was broad daylight and several tugboats of the company were at work close by. Yet the flames, which were first discovered in the engine-room, drove the engineer from his post in a few seconds, and spread so rapidly that there was a panic among the passengers, in which one man broke his leg, and several trucks, with the horses attached, had to be abandoned to the flames. The boat was so close to the ferry bridge that the lines were thrown from it, and the men at the windlasses pulled the boat back so that the

frightened passengers could escape to the dock. In less than five minutes, despite the fact that a half dozen tugboats were pouring streams of water on the fire, the boat had to be pulled out of the slip to save the ferry-house from burning, and with all the tugs that could crowd about her pouring on water, she burned to the water's edge and sank.

It is doubtless somewhat cheaper in point of first cost to build of wood the light superstructure above the main deck of a ferryboat. But its only use is to protect the passengers from the weather; it burns as easily as a structure of cardboard; and we can conceive of no reason why every part of it could not be built of incombustible materials, and serve equally well every purpose of shelter, with no very great increase in expense, taking maintenance into consideration. The same reform might and should be applied to the construction of all our river steamers; but the more intricate accommodations required there make the construction of a perfectly fire-proof structure rather more difficult.

The Status of Iron and Steel Manufacture.

The annual report of the American Iron & Steel Association is always a document worth reading, and this year it is particularly so. It combines two merits not often combined in statistical publications, covering a wide range of records, promptness of appearance and completeness. The report this year gives complete statistics of the production and prices of all the principal iron and steel products of the United States in 1888 and recent years; of the production of iron ore and coal in the United States in 1888 and recent years; of the construction of railways and iron and steel ships, and of imports and exports of iron and steel and iron ore. It also gives similar statistics for all the leading foreign countries, and a careful and intelligent review of the present condition of the iron and steel industry.

No country in Europe is better served in respect to such statistics of this great industry than we, and as it is the barometer of all other industries, we cannot do our readers a better service than to abstract the more salient facts with some fulness. We supplement the statistics of the report with some statistics of earlier years from other sources, and give only round figures, as answering every present purpose while much more readily comprehensible.

The coal interest, which lies at the foundation of the iron interest, has varied as follows in the leading countries of the world since 1880:

Production of Coal (Millions of Long Tons).

	1888	1887	1886	1885	1884	1880
United States	123.7	110.7	100 7	99.1	106 9	63.7
Great Britain	169.9	162.1	157.5	159.3	160.8	147.
France	....	....	21.4	19.9	....	19.
Belgium	....	....	18.4	17.3	....	17.
Austria	....	....	....	20.8	20.4	16.
Russia	....	....	....	....	4.2	7.
Australia	....	....	2.9	2.8	....	....
Per cent. of U. S. to Great Britain	72.8	69.0	64.0	62.3	66.4	43.2

In the 8 years since 1880 American coal production has increased 94.2 per cent., and British, 15.6 per cent. This seems an enormous contrast, yet it is not really so very different from what has existed for the past 20 years. Thus, between 1860 and 1880, the American coal output increased 366.7 per cent., and the British 72.9 per cent., which is *at the rate* of 85.2 and 24.5 per cent. respectively in 8-year periods.*

* All such calculations are extremely simple to make by logarithms. Thus, if we have an output a, and output b, c years apart, $log.\ a - log.\ b = log.$ of increase in output; $\frac{log.\ a - log.\ b}{c} = log.$ of annual ratio of increase, $(log.\ a - \frac{8}{c}\ log.\ b) - =$ ratio of increase in 8 years, etc, etc.

The rest of the world cuts a very small figure, the English-speaking nations between them doing almost all the coal mining. Germany produces the largest amount of any continental nation (in 1880, 59 million tons) but untortunately the report does not give the coal output of Germany. In 1880 the English-speaking countries produced two thirds of the world's coal. At the present time they produce fully four-fifths.

And right here we may say that, just as New York, as a metropolis, loses its proper rank as a city of 2½ to 3 million people by being divided into Brooklyn, Jersey City, Hoboken, Newark, and what not, so in the sharp rivalry which exists between Great Britain and the United States, we are apt to lose sight of what is really the larger fact, the one of more permanent interest and significance, viz., the overwhelmingly dominant part which the English race, *as a race*, is playing in the modern world. For this country is practically of the English race and nothing else, if we except the negroes. Only 86.7 per cent. of our population are native-born, it is true; but of the remaining 13.3 per cent. of foreign-born, an even quarter are from England, Scotland, and the British colonies, and of the remaining 10 per cent. about 8½ per cent. are of Germanic and Celtic extraction in almost the exact proportion in which those races were originally mingled to form the English race. The remnant of only 1½ per cent. of Italian, Chinese, Russian, and other like distinctively foreign elements, is not enough to seriously modify or change racial characteristics.

Although the separation of the English-speaking race into two great parts seems at present a most decided and enduring one, yet time brings great changes, and in this age often speedy ones, and it is at least a striking fact to bear in mind that one great race as a whole, numbering little more than 100,000,000, is doing all but a trifling fraction of the world's mining and manufacturing.

The production of pig iron, since 1870, has varied as follows:

Production of Pig Iron (Millions of Long Tons)

	1888	1887	1886	1885	1884	1882	1870
Un. States	6.49	6.42	5.69	4.04	4.09	4.62	1.58
Great Britain	7.90	7.56	....	....	7.53	8.40	5.23
France	1.69	1.57	1.52	1.63,	....	2.03	1.23
Belgium	0.83	0.76	0.70	0.71	0.75	0.64	0.26
Germany	4.23	3.91	3.53	....	....	3.13	1.31
Austria	....	....	0.72	0.71	....	0.55	0.28
Russia	....	....	....	0.52	....	0.51	0.36

We are still a little below Great Britain, but have increased over 61 per cent. since 1882, nearly all of it in the last three years, while Great Britain has not even held her own. She made an enormous jump from 1879 (5.98 million tons) to 1882 (8.49 million tons but since then has fallen off in output. It is evident that within a year or two we shall pass her; but in the meantime the two countries together produce about two-thirds of the world's iron, Germany being the only other large producer, and making an extremely good showing.

Our production of steel, in thousands of *short* tons, has ranged as follows in recent years:

	1888	1887	1886	1885
Bessemer steel	2,812	3,288	2,541	1,702
Open hearth steel	352	361	245	149

The falling off from 1887 is decided, and it is not wholly without significance that Great Britain, on the other hand, increased her output of Bessemer steel some 14 per cent. and her output of open hearth steel still more largely, although we have not the exact figures for the latter increase. The comparative figures in thousands of *long* tons are:

		1888	1887	1881
United States	Bess.	2,511	2,903	1,074
	O. H.	314	272	
Great Britain	Bess.	2,300	2,080	1,790
	O. H.	1,200	——	

We have a little more than doubled, and Great Britain a little less than doubled since 1881, but honors are substantially easy comparing 1881 with 1888, whereas the year before we had considerably the largest output.

Our consumption of pig iron was last year about 200,000 gross tons, or 3 per cent. over our production; the year before about twice that.

The South is slowly but surely creeping up on the rest of the country in the iron industry, as is strikingly indicated by the fact that it produced last year more than the entire production of the country in 1865. Nevertheless, Pennsylvania holds its own pretty well, considering that ore is now being put on the cars in Alabama for from 50 cts. to $1.00 per ton; and Ohio has maintained a singularly close parallel with the South since 1883, before which date the South evidently knocked out of blast a number of its furnaces, as it has done in other States since. The following table shows the production of the great iron centers separately since 1878, to which we add the earlier dates and a table of percentages.

Production of U. S. Pig Iron (Thousands of Net Tons.)

	1888	1887	1886	1885	1884	1883	1882	1880	1878
9 Sou. States	1,133	929	875	713	658	699	577	397	228
Penna.	3,589	3,685	3,293	2,445	2,385	2,639	2,449	2,093	1,342
Ohio	1,104	976	908	554	567	677	699	674	421
Other States	1,443	1,597	1,289	818	980	1,132	1,453	1,141	587
Tot'l U.S.	7,269	7,187	6,365	4,530	4,590	5,147	5,178	4,295	2,578

Percentages.

Southern	15.6	12.9	13.7	15.7	14.3	13.6	11.1	9.3	8.8
Penna.	49.4	51.3	51.7	54.0	52.0	51.2	47.4	48.4	52.1
Ohio	15.2	13.5	14.3	12 2	12.3	13 2	13.5	15.7	16.3
Other	19.8	22.3	20.3	18.1	21.4	22.0	28.0	26.6	22.8
Tot'l U.S.	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

It appears to be the general opinion (although no predictions are ventured in this report, which confines itself to facts) that progress in the South is to continue rapidly. It is almost entirely confined to Alabama, Tennessee, and Virginia in the order named. West Virginia advances slowly, while Maryland, Kentucky, and Georgia have fallen off.

The proportion of anthracite pig is rapidly falling off. In 1884 it was about one-third; in 1888 about one-fourth. About 8 per cent. (599,000 tons) of our pig is still charcoal pig. The Bessemer pig aggregates 2.95 million tons against 3.22 in 1887, a natural falling off in view of the decrease in steel output. Of this Bessemer pig, unfortunately, the South produces almost none. The report says:

> We have annually for several years consumed more iron and steel than any of the great European countries. The *per capita* consumption of iron and steel by the United States is also greater than that of any other country. In 1887 our consumption of finished iron and steel *per capita* exceeded 300 lbs. [assuming population at 60,000,000, which is too low.—ED.] In 1888, it declined to probably 285 lbs. We make more use of railways, heaters, ranges, stoves, wire fencing, sheet-iron and tin-plate roofing, agricultural machinery, etc., than the people of any other country.

In 1882, MULHALL gives the *production* of Great Britain as 555 lbs. per inhabitant, against 196 lbs. in the United States, but in that year somewhat more than half the iron produced was exported, so that the consumption was about 270 lbs., if there was no change in stock on hand.

There is little change in the center of gravity of the Bessemer steel trade. Pennsylvania produced in 1888 56 per cent. of all, against 65 per cent in 1885, and Illinois, 22 per cent. the same as in 1885. One of the most significant facts in the report, however, is the very rapid increase in use of Bessemer steel for other uses than for rails. Deducting from the make of Bessemer ingots 12½ per cent. for oxidation and crop ends, the following figures are obtained, in thousands of net tons:

	1888	1887	1886	1885	1884	1883
Bessemer rails	2,460	2,887	2,224	1,489	1,348	1,448
Other Bessemer	901	587	474	414	351	194

This shows rapid and steady expansion in the use of steel for miscellaneous uses, especially as there is a large and increasing use of the metal in addition to this by working up scrap rails and crop ends.

The production of rolled iron in all forms shows no tendency to increase, being no larger now than it was in 1880, or about 2,400 thousand tons. This of course is due to the competition of steel. Iron cut-nail output has decreased to but little over a quarter of what it was at its maximum in 1883, and is not much over half what it was in 1873. Two-thirds of the nails made last year were steel, the total of nails reaching the enormous aggregate of 324,679 net tons.

A table of some special interest is the tonnage since 1874 of steel rails for street-car lines which has increased at the following very rapid rate, in thousands of net tons:

1874	6.7	1879	8.6	1884	31.4
1875	16.3	1880	16.9	1885	36.0
1876	13.1	1881	21.6	1886	48.0
1877	7.0	1882	22.3	1887	57.4
1878	9.2	1883	19.4	1888	50.3
Totals for 5 years	52.3		88.8		223.1

In other words, the consumption has about quadrupled within ten years.

The output of the Lake Superior ore region has doubled since 1884 and quadrupled since 1878, being now about 5,000,000 tons.

The comparative output of anthracite and bituminous coal has been, in millions of gross tons:

	Anth.	*Bitum.*	*Total*	*P. C. Anth.*
1870	13.99	15.36	29.34	47.7
1880	25.58	38.19	63.77	40.1
1888	38.91	84.77	123.67	31.5

Our iron and steel shipbuilding interest makes the following gratifying and brilliant exhibit when compared with that of Great Britain:

Tonnage of new ships.	1888.	1887.
British	903,000	582,000
United States	36,718	34,354

This does not include on our side any United States naval vessels, which in late years would have gone well on toward doubling our tonnage; but even with that added, we show poorly indeed. Perhaps some day we shall build ships once more, but the day is not yet.

The Memphis System of Sewerage.

We published two weeks ago a letter from Col. GEO. E. WARING, Jr., in reply to an editorial of ours in the preceding issue, and in our present issue we give a letter from Mr. RUDOLPH HERING replying to certain personal statements in Col. WARING's letter. All parties having had their say, we might perhaps leave the questions involved to our readers without further comment; but those questions are important, and as it appeared to us that Col. WARING's response dealt chiefly with side issues, silently passing by the real issues, it seems right that we should say a few words more on the subject.

The real issue is, as it seems to us, whether the method of sewering which he has patented and prominently urged for adoption in many cities on both sides of the Atlantic, is an improvement over the methods previously known and used, or whether it is not. This, at least, is the way we desire "to put the case," for it seems to us the fair way. We certainly desire to accord him credit for all real improvements in the methods of sewering, but we desire to be just in our criticism, and do not wish to deny the credit to English engineers if it is theirs. And while it would be wrong and unfair for us to interfere with any one who legitimately endeavors to obtain all the financial profit he can from his inventions, we consider it entirely within the province of this journal to record results of experience, to inform our readers as to how far engineering works have succeeded or failed, and to endeavor to place credit or blame where it belongs.

This journal was instrumental in widely circulating RAWLINSON's "Suggestions" in 1878 and it reprinted an edition of BALDWIN LATHAM's "Sanitary Engineering" in the same year. It has given its readers opinions upon questions of sewerage that were held and methods that were practised by both American and English engineers. It printed in full a report to the National Board of Health upon European sewerage systems, by Mr. RUDOLPH HERING, who in our present issue enumerates the essential features of the separate system of sewerage, which he found endorsed in 1880, while preparing for the above report. The facts on which to base a judgment are all on record in the columns of this journal. We will not attempt to again summarize them.

Suffice it to say, and this we believe is not disputed, Col. WARING in his Memphis work deviated from the previously accepted practice by endeavoring to rigidly exclude *all* rainwater, instead of making a provision for some of it; in limiting the sizes of public sewers to 6 ins. until at the hour of greatest flow they would run half full, instead of making the limit 8 ins. or 9 ins.; in disregarding the straight alignment between points of access and making curves at such points; in laying the sewers only a few feet (4 to 6 ft.) below the surface; in considering manholes simply as a means for ventilation, not for cleansing, and, therefore, advising them to be placed at intervals of not less than 1,000 ft.; and in ventilating the public sewers through the private drains of every house. This is the whole list of deviations from past practice as we understand it. There are no other essential deviations from the English practice of many years before. How have these deviations worked? We cannot pretend to speak from personal knowledge and inspection, and are open to correction; but regarding these, Mr. HARTFORD, the Superintendent in charge of the sewerage, in his candid and conscientious report (for such it certainly seems to be), published in abstract in our issue of April 6, reaches the following conclusions as a result of his nine years' experience:

1. That the laterals and mains are of insufficient size. There are stated to be over two stoppages of flow per week in the 6-in. laterals, and nearly 40 per week in the 4-in. house drains. Many of the mains are said to be overcharged by the ordinary service of the sewers. He recommends for the new district a minimum size of 8 ins. for the public sewers, and 6 ins. for the house-connecting branches, extended to the sides of the street or alley.

2. That all changes of line, both vertical and horizontal, should be made in manholes.

3. That the depths of the sewers in many places have proved wholly inadequate, and

4. That manholes for purposes of inspection and cleaning should be built at every street intersection, *i. e.*, about 380 ft. apart.

The only essential deviation from the English practice which does not seem to have been found objectionable in Memphis, so far as we can understand the facts, is the ventilation of public sewers through private house-drains. But as this way of ventilation has been the customary one in the best sewered cities of the continent, it certainly cannot be regarded as what the patent attorneys call a "patentable novelty."

Granting the preceding facts, which can hardly be disputed, we are unable to discover where the great "improvements" come in in the Waring system. If the pipes had been made one size larger and had been laid perfectly straight between intersections or junctions, it would surely appear that there should not be so many stoppages to-day, nor probably any that could not be more speedily and cheaply removed. If most of the manholes had been temporarily omitted at intersections, and built later as required, and if a slightly larger mileage of sewers had been left unbuilt during the first year and added to thereafter, the demand for economy at the time would have been satisfied just as well. In other words, if the work had been designed as outlined in RAWLINSON's "Suggestions," with natural modifications to suit American conditions and special economy, the city of Memphis would have been provided with at least a solid foundation for a good and permanent sewerage.

We should add that our reference to Col. WARING's paper read before the Sanitary Institute was inadvertently credited to the Institute of Civil Engineers. We were concerned in what he said rather than where he said it, and trusted too much to memory. Neither must we be understood as seeking to detract in the slightest from Col. WARING's just credit for services to the cause of good sanitary engineering. He has done much to popularize an interest in and knowledge of good sanitation, and thus to make possible good work. That his labors have been equally instructive to engineers, and have materially improved or advanced sewerage practice, we do not understand to be the case. Facts are facts, and the fact seems to be that the more novel and distinctive features of the Memphis sewerage system have been precisely those where most trouble has arisen. That that system "substantially unchanged" has been applied to "between 40 and 50 towns of the United States" is a claim which we are astonished to hear advanced, and which we do not believe can be substantiated even as respects half that number of towns; and unless we are misinformed, some of the towns of which the statement is true have had reason to regret that it is so.

The Water-Works of the United States and Canada.

II.

We give this week, in continuation of the article in our last week's issue, the concluding tables which should have appeared in that article, but for which we were unable to find room. For notes of the more salient points in these tables, we must refer to the concluding part of our last week's article: but for the most part the tables explain themselves, and need only to be studied. How vast an interest the water-works of the United States have become was shown in the colored diagram, which we gave last week, and to which also we refer.

THE INTERSTATE RAILWAY COMMISSION has sent notice to about 150 railway companies that the following questions have arisen in the case of GEO. RICE, of Marietta, O., vs. the Cincinnati, Washington & Baltimore R. R., and any company interested in the decision is invited to present before the Commission arguments and evidence on the questions at issue.

The question of the like classification of barrel and tank oils and of the right of the railroad companies to charge for the weight of the barrel package in addition to the weight of contents.

Discrimination arising from the returning of empty tank cars free of charge, and also of the paying a mileage rate on such empty tank cars.

Whether railroad companies are not obliged to furnish tank cars, as well as cars of other descriptions for oil transportation.

THE EDISON GENERAL ELECTRIC CO. filed a certificate of incorporation at Albany, N. Y., on April 23, with a capital stock of $12,000,000. The incorporators are HENRY VILLARD, THOMAS A. EDISON and their associates. The purpose is to consolidate the interests of the Edison Electric Light and Edison Manufacturing companies.

TABLE 13—S.

OWNERSHIP OF UNITED STATES AND CANADIAN WATER-WORKS, WITH POPULATION SUPPLIED BY PUBLIC WORKS, ETC.

	New England	Middle.	So. Atl.	So. C.	No. C.	N. W.	S. W.	Pacific.	Total U. S.	Canada.
City or town	119	137	41	13	211	128	47	19	715	41
Local company	149	248	30	41	86	81	84	93	812	15
Outside company	9	1	1	.....	19	11	1	.....	42	3
Individuals	8	19	1	1	11	6	3	16	65	9
Unknown	2	3	.....	.....	2	.....	1	.....	8	.....
Total No	287	408	73	55	329	226	136	128	1.642	68
Population supplied by public works	1.740,574	4.829,527	315.193	147,165	2,246,068	271,961	437,023	69,180	10,086,691	556,696
P. C. of population supplied by city works	72·3	78·3	64·4	21·5	74·6	40·5	51·8	12·9	67·4	75·7
Population on private works	668,785	1,336,091	190,876	537.124	764.664	400,072	406,448	466,861	4,770 921	180.347
Population per private work	3,980	4,930	6,000	13,080	6,435	4,080	4.564	4,280	5.130	6,679
P. C. of census city pop'n supplied by public works.	87·5	85.2	72·6	22·1	83·6	58·1	62·4	16.5	77·5	.....

TABLE 9—S.

UNITED STATES AND CANADA WATER-WORKS—KIND OF WORKS.

GROUP.	Gravity.	Pumping to				Unkno'n	Total.	P. C. gravity works.
		Reservoir.	Tank.	Stand-Pipe.	Direct.			
New England	130	50	21	31	21	5	258	50·4
Middle	175	116	23	44	40	4	412	42·4
So. Atlantic	12	18	19	13	10	2	74	16·2
So. Central	5	17	5	21	5	3	56	8.9
No. Central	16	46	51	72	141	5	331	4.8
Northwestern	18	46	50	60	47	3	224	8·0
Southwestern	29	27	35	41	21	1	144	20.1
Pacific	75	32	20	5	9	2	143	52.5
Total U. S	460	332	214	287	294	25	1,632	28.2
Canada	24	9	5	4	30	.....	72	33.3

Some of the works have a double system which increases the total. Several gravity works have small auxiliary pumping systems for special service which have been disregarded. Most of the pumping works pump direct in case of fire.

TABLE 10-S.

UNITED STATES AND CANADIAN WATER-WORKS.—SOURCES OF SUPPLY.

[Several works in each group have double sources of supply, increasing the totals by so much.]

GROUP.	S'rface	Spring	Brook.	River.	Lake.	Creek.	Wells.	Unk'n.	T'tal.
New England	36	45	42	36	70	.....	20	9	258
Middle	34	103	44	89	18	61	38	4	411
So. Atlantic	2	18	3	18	6	6	19	2	74
So. Central	2	12	3	20	.....	5	9	3	54
No. Central	10	30	.....	87	44	15	138	9	33
Northwestern	7	11	1	62	6	14	113	19	233
Southwestern	7	17	2	66	2	16	35	2	147
Pacific	4	27	8	36	4	19	29	4	133
Total U. S	102	263	108	416	150	136	421	52	1.643
Canada	4	12	2	31	14	5	1	1	70

PERCENTAGES.

New England	14·0	17·4	16.3	14.0	27.1	.....	7·7	3.5	100·0
Middle	8.3	25·1	10·7	21·6	4·4	14·8	14.1	1·0	100·0
So. Atlantic	3·1	4·7	4.7	29·7	4·7	8.6	21·9	3·9	100·0
So. Central									
No. Central	3·0	9·0	.....	26.1	13.2	4.5	41.5	2·7	100.0
Northwestern	3.0	4.7	0.4	26.6	2·6	6.0	48.5	8.2	100.0
Southwestern	4.8	11.5	1.4	44.8	1·4	10·9	23.8	1 4	100.0
Pacific	3·0	20·3	6.0	28 6	3.0	14.3	21.8	3.0	100.0
Total U. S	6.1	16·1	6.1	25.4	9.1	8.3	25.7	3.2	100.0
Canada	5.7	17.1	3 0	44·3	20·0	7·1	1·4	1·4	100.0

TABLE 11—S.

UNITED STATES AND CANADIAN WATER-WORKS.—AVERAGE WORKING PRESSURES.

[Representing in some of the gravity works the mean pressure in the mains In pumping works, however, and in most of the gravity works, the pressure is that at the pumps, or principal mains, and hence, considerably higher than the effective pressure.]

PRESSURE per sq. in.	No'w'n.	So'w'n.	Pacific.	Total Far W'n.	Total Eastern.	Total U. S.	Total Canada.
Under 20	2	1	.....	3	13	16	.....
20-29	11	3	11	25	35	60	2
30-39	9	6	13	28	94	122	5
40-49	46	25	22	93	177	270	15
50-59	20	13	6	39	120	159	6
60-69	30	24	12	75	129	204	11
70-79	15	6	14	35	123	158	6
80-89	14	13	13	40	86	126	9
90-99	4	6	4	14	61	75	2
100-109	9	4	3	16	31	47	3
110-119	3	3	.....	6	22	28	3
120-129	2	1	.....	3	24	27	1
130-139	.....	1	.....	1	4	5	.....
140-149	2	.....	1	3	2	5	.....
150-159	.....	2	4	6	8	14	.....
160-169	1	1	.....	2	2	4	.....
170-179	1	1	1	3	4	7	.....
Total Works reporting.	178	110	104	392	935	1,327	61

A few works report an ordinary pressure of 200 lbs., but as these are doubtful they have been omitted.

TABLE 12-S.

FIRE PRESSURES OF UNITED STATES AND CANADIAN WATER-WORKS, WHEN THE SAME ARE HIGHER THAN THE NORMAL WORKING PRESSURES.

[Nearly all the following are pumping works, but there are a few gravity works which are able to turn on a higher fire pressure from higher reservoirs.]

FIRE PRESSURES, lbs per sq. in.	N'w'n.	S'w'n.	Pacific.	Total Far W'n.	Total Eastern.	Total U. S.	Total Canada.
40-49	.....	.....	3	3	6	9	1
50-59	.....	.....	2	3	9	11	.....
60-69	.....	2	3	5	22	27	2
70-79	5	1	3	9	27	36	7
80-89	8	3	6	17	56	73	4
90-99	12	3	4	19	51	70	3
100-109	32	15	6	53	84	143	7
110-119	5	2	2	9	23	32	3
120-129	29	15	4	48	51	99	6
130-139	2	10	2	14	16	30	1
140-149	4	2	.....	6	17	23	.....
150-159	11	9	2	22	32	54	4
160-169	3	2	1	6	7	13	.....
170-179	1	.....	1	2	9	11	1
180-189	.....	.....	.....	.....	3	3	.....
190-199	1	.....	.....	1	2	3	.....
200	5	3	2	10	1	11	1
Total works reporting.	118	67	41	226	416	642	40

TABLE 12-S (2).

AMOUNT OF INCREASE ABOVE NORMAL PRESSURE.

	Total N'w'n.	Total S'w'n.	Total Pacific.	Total Far W'n.	Total Eastern	Total U. S.	Total Canada
Under 20	2	1	6	9	50	59	4
20-29	5	1	9	15	42	57	7
30-39	11	11	5	27	40	67	11
40-49	21	7	5	33	71	106	3
50-59	14	5	5	28	53	81	4
60-69	12	13	1	26	57	93	3
70-79	9	13	2	24	44	68	1
80-89	6	3	3	12	27	39	6
90-99	9	5	1	15	6	21	1
100-109	4	.....	1	10	11	21	.....
110-119	4	.....	1	5	3	8	.....
120-129	1	.....	1	2	9	11	.....
130-139	2	.....	.....	2	3	5	.....
140-149	1	1	.....	2	.....	2	.....
150-159	.....	1	1	2	.....	2	.....
160-169	1	1	.....	2	.....	2	1
Total works reporting.	118	67	41	226	416	642	40

TABLE 4—I-J.

CANADA MARITIME, INTERIOR AND WESTERN PROVINCES WATER-WORKS—SUMMARY BY PROVINCES OF THE MAIN STATISTICS GIVEN IN TABLE 3-C-D.

Province.	Pop'n on Water-Works 1880 census.	No. of Works	Present Finances.		Miles of Mains.	Number of		
			Cost.	Revenue		Taps.	Hydr'ts.	Meters.
New Brunswick	60.253	(1) 5	1.497,797	124,605	92·75	17,314	558	157
Nova Scotia	50.591	7	1,147.000	82.000	110	6,265	450	6
Prince Edw's Id.	11.485	1	165,000	5,000	15.25	195	88	.....
Newfoundland	30,770	3	498.000	31,900	29	2,141	207	.....
Totals, Maritime	153,099	(1) 16	3,307,797	243,505	247	26,015	1,303	163
Quebec	263 816	(2) 14	9,524,780	779,529	495.8	87,020	3,018	1,404
Ontario	312,128	35	7,731,272	843,535	583.35	57,374	4,706	481
Manitoba	8,000	1	250,000	40 000	20	600	150	.....
British Columbia	.....	2	800,000	48,500	23	1.938	134	29
Tot'ls. Int. & W'n	583,994	(2) 51	18.006.012	1,711 564	1,'24	146,932	8,008	1,914
Total Canada	737,043	(3) 68	21 313 809	1,955,069	1,371	172,947	9,314	2,077

TABLE 15-S.

UNITED STATES AND CANADA WATER-WORKS.—HYDRANT RENTAL.

(Nearest even $5 taken.)

Hydrant rate.	N'w'n.	S'w'n.	Pacific.	Total Far W'n.	Total Eastern.	Total U. S.	Total Canada.
Free	1	1	15	17	26	43	5
$5	.....	.....	2	2	9	11	.....
10	.....	.....	2	2	16	18	.....
15	.....	.....	.....	.....	29	29	.....
20	.....	.....	4	4	22	26	1
25	.....	1	6	6	24	30	.....
30	1	2	2	5	33	38	1
35	1	1	.....	2	26	28	1
40	3	2	4	9	44	53	2
45	1	2	1	5	27	32	1
50	13	12	4	29	60	89	7
55	3	.....	.....	3	8	11	.....
60	9	8	1	18	24	42	.....
65	2	4	1	7	.....	7	.....
70	4	4	.....	8	.....	8	1
75	12	4	.....	16	24	40	.....
80	5	4	11	20	.....	20	.....
85	3	6	1	10	.....	10	.....
90	.....	3	.....	3	4	7	.....
95	.....	.....	.....	.....	.....	.....	.....
100	18	15	3	36	5	41	1
120	.....	.....	1	1	.....	1	.....
125	.....	1	.....	1	.....	1	.....
150	.....	1	.....	1	.....	1	.....
160	1	.....	.....	1	.....	1	.....
Totals.	77	71	58	206	381	587	20
Average rate, including the w'ks reporting free rentals.	$70	$70	$40	$60	$35	$45	$35
Average rate, excluding the w'ks reporting free rentals.	70	75	50	65	40	50	50

The above includes all the works which report a hydrant rental separately Nearly all the private works receive an indirect rental of some stated sum including water supply of city buildings, etc. Some of the works have a sliding scale decreasing from the above rates for additional hydrants.

TABLE 16—S.

UNITED STATES AND CANADIAN WATER-WORKS.—PUMPING CAPACITY IN MILLIONS OF GALLONS PER DAY.

Makes of Pumps arranged alphabetically.	N. Eng.	Middle.	S. Atl.	So. C.	No. C.	N. W.	S. W.	Pacific.	Total U. S.	Canada.
Blake	21.4	26.1	4.2	34.2	51.5	30.5	25.9	3.0	196.8	5.5
Buffalo	.....	5.5	.....	.....	.....	10.6	5.5	.....	21.6	.....
Cameron	.....	1.6	.....	.....	3.0	0.1	1.0	1.0	6.7	.....
Corliss	20.0	22.0	.....	.....	.....	.....	.....	.....	42.0	.....
Cornish	9.0	19.3	.....	.....	75.0	.....	.....	.....	103.3	.....
Davidson	12.5	28.7	.....	5.0	3.5	.....	.....	.....	49.7	.....
Deane*	39.5	19.4	13.6	29.6	85.0	36.3	17.1	.....	240.5	.....
Dow	.....	.....	.....	.....	.....	.....	.....	8.4	8.4	.....
Gr'l. & Maxwell	.....	8.5	5.1	7.5	62.3	20.1	5.8	.....	109.3	2.0
Holly-Gaskill	17.5	156.9	21.0	60.0	276.8	78.6	60.1	12.8	683.7	4.0
Hooker	.....	.....	.....	.....	.....	.....	.....	8.7	8.7	.....
Knowles	19.5	32.1	8.9	9.1	62.4	36.2	16.0	5.3	189.5	3.7
Lang	6.5	8.2	.....	.....	.....	.....	.....	.....	14.7	.....
Lowry	.....	10.0	.....	.....	2.0	.....	.....	.....	12.0	.....
Smith & Vaile	.....	.....	4.0	.....	18.1	7.8	13.2	.....	42.9	.....
Walker	.....	.....	.....	.....	31.6	.....	2.0	.....	33.6	4.9
Wetherill	.....	12.0	.....	.....	.....	.....	.....	.....	12.0	.....
Wood	2.5	5.0	5.0	.....	.....	.....	.....	.....	20.5	.....
Worthington	123.8	344.6	39.9	47.5	145.0	55.3	82.9	32.3	871.3	51.7
Wilson & Snyder	.....	6.6	1.0	.....	.....	.....	.....	.....	7.6	.....
Misc. & Unrep'd†	62.9	273.7	37.3	33.2	351.1	133.5	136.8	21.8	1,050.3	72.9
Total	342.1	987.2	140.0	226.1	1,167.3	408.8	366.3	93.3	3,725.1	144.7

† The miscellaneous includes all pumps of unreported or unknown makes, all water-power pumps and all small or miscellaneous makes. It is estimated that the actual pumping capacity is at least 400 million gallons larger than shown above, many pumps having no capacity reported, and not a few pumps not being reported at all. The Worthington company have furnished the publishers a list showing 220 million gallons of daily pumping capacity in addition to the 871.3 capacity shown above, of which about half is included in our "Miscellaneous and unreported" total of 1,050.3 million gallons, and the remainder, or about 12 per cent., is not specifically included at all. It is probable that other makers could furnish a similar list, but as others have not done so, it was not deemed fair to correct the record of one maker only.

*These totals include about 20 million, more or less, of "Dean" pumps, an entirely different make. There was so much confusion in the spelling as to make it appear impracticable to separate the "Deane" and "Dean" pumps correctly in this issue; so both are given together.

TABLE 14—S.

UNITED STATES AND CANADA WATER WORKS.—USE OF METERS.

	Over 100 Meters		Under 100 Met's		No Met's Report'd	No. of Works Report'g Meters.	Total Meters.
New England	31	36,111	99	1,802	157	130	37,913
Middle	23	32,345	124	2,001	287	147	34,346
South Atlantic	4	2,655	17	234	52	21	2,889
South Central	5	2,073	19	292	31	24	2,365
North Central	16	10,360	80	1,445	233	96	12,085
Northwestern	6	2,347	62	1,100	158	68	3,447
Southwestern	5	3,721	46	704	85	50	4,425
Pacific	5	9,595	20	350	103	25	9,945
Total U. S	95	99,217	467	7,928	1,106	562	107,415
Canada	4	1,278	26	797	38	30	2,077

TABLE 5-I J.

CANADA MARITIME, INTERIOR AND WESTERN PROVINCES WATER-WORKS.—SUMMARY BY DATES OF FIRST CONSTRUCTION OF THE MAIN STATISTICS OF ALL CANADIAN WATER WORKS, AS USUALLY GIVEN IN TABLE 3.

CANADA MARITIME PROVINCES.

Date.	Present p'p'n of water-works.	No. of works.	Present Finances. Cost.	Present Finances. Revenue.	Miles of Mains.	Number of Taps.	Number of Hyd'rts.	Number of Meters.
1846-70	98,415	3	2,213,797	171,848	126.7	21,624	763	144
1851-60	.....	.....	.....	.....	.....	.....	.....	.....
1861-70	11,570	2	181,000	11,500	11.3	502	7	.....
1871-80	8,544	2	140,000	11,400	15.	800	62	.....
1881-85	18,506	5	453,000	22,857	49.75	2,079	226	19
1886-88	16,064	(1) 4	318,000	25,900	44.25	1,010	184	.....
Total Maritime.	153,099	(1) 16	3,307,797	243,505	247.00	26,015	1,306	163

CANADA INTERIOR AND WESTERN PROVINCES.

1801-50	241,160	3	9,193,000	925,331	306.75	58,911	2,770	982
1851-60	101,442	3	3,280,000	263,581	115.8	16,415	855	.....
1861-70	9,636	1	60,961	8,458	7.5	108	96	12
1871-80	126,719	(1) 16	2,982,939	297,565	482.7	63,476	2,871	94
1881-85	49,370	(1) 9	982,000	95,072	89	3,624	646	191
1886-88	48,006	17	1,133,112	71,937	99.4	1,790	632	6
Unknown.	7,621	3	375,000	49,600	32	2,608	88	29
Total Int. & Wn	583,934	(2) 52	18,006,012	1,711,564	1,124	146,932	8,008	1,314

GRAND TOTALS, CANADA MARITIME, AND INTERIOR AND WESTERN PROVINCES.

1801-50	329,575	6	11,406,797	1,097,179	433.45	80,535	3,533	1,126
1851-60	101,472	3	3,280,000	263,581	115.8	16,415	855	.....
1861-70	21,196	3	243,961	19,958	18.8	610	167	12
1871-80	135,263	(1) 18	3,122,939	309,965	497.7	64,276	2,933	694
1881-85	67,876	(1) 14	1,435,000	117,929	138.75	5,703	872	210
1886-88	64,070	(1) 21	1,450 112	97,857	134.65	2,800	866	6
Unknown.	7,621	3	375,000	49,600	32	2,608	88	29
Grand T'tls.	737,043	(3) 68	21,313,809	1,955,069	1,371	172,947	9,314	2,077

BOOK REVIEWS.

American Weather: A Popular Exposition of the Phenomena of the Weather, including Hot and Cold Waves, Blizzards, Hail Storms and Tornadoes. By Gen. A. W. GREELY, Chief Signal Officer, U. S. A. pp. 286, 32 engravings, 24 charts. Dodd, Mead & Co., New York.

It is only within very recent times that the phenomena of the weather have been attentively studied; and how much has been already accomplished in the way of knowledge of its phenomena is indicated even by this popular volume, which, making no pretence to elaborate technical precision, is all the more likely to be generally useful. Every constructing engineer especially is likely to find the work interesting and instructive reading, and in many cases directly useful.

The plates of such a volume as this are naturally examined with especial interest, as giving in condensed graphical form a vast amount of information readily grasped by the eye. It would be impossible to abstract in words any considerable fraction of this information, but a few of the more salient facts we may perhaps profitably note.

The lines of "Average Date of First Killing Frost" run nearly east and west, tending slightly E. N. E. and W. S. W. Dec. 1 is the date along the Gulf, Nov. 1 in Central Texas, Mississippi and Georgia, Oct. 1 in Nebraska, Southern Iowa, Illinois, Ohio, Pennsylvania and the New England Coast, Sept. 15 in Denver, Chicago, Toledo, Buffalo and Montreal, and Sept. 1 in Manitoba, St. Paul, northern Michigan and Ottawa. In the northwestern United States the lines run nearly north and south.

In the dryest Rocky Mountain region in July there are 4 gr. of water per cu. ft. of air; in the South Atlantic and South Central States, 7 to 9 gr.; and in the northerly tier of States, as also in western Texas and Nebraska, 6 gr. No part of Canada seems to run over 5 gr., but evaporation is there much less.

Cloudiness in August ranges from 30 per cent. in Salt Lake, and north and south of it, to over 50 per cent. along the Atlantic coast, the Pacific coast being very low with 10 to 20 per cent.

In January both the Pacific and Atlantic coasts show 50 to 70 per cent. of cloudiness, the greatest being at the north instead of the south. A vast basin around Salt Lake, Santa Fé, and Denver has under 40 per cent.

The chart of mean annual temperature for the whole northern hemisphere is a very interesting one, but almost impossible of description. It vividly illustrates the impossibility of comparing climates in Europe and America by latitude. Great Britain has the latitude of northern Labrador, but the isothermal of Labrador and northern Manitoba hardly touches the map of Europe at all. Newfoundland, New Brunswick, Quebec, and northern Ontario have the average temperature of northern Norway and Sweden, as have also southern Alaska and northern Japan.

The two charts showing the "Continuance of Daily Mean Temperature above 50°" and "below 32°" are among the most interesting, but are impossible to describe, except that the lines run nearly east and west in the eastern two-thirds of the continent, and tend rather to north and south along the northwestern international boundary.

The highest temperature ever observed in 18 years (1871-88) is (neglecting one or two scattering excesses of 1° to 2°) 110°, which runs in a nearly straight line north from near Vera Cruz, Mexico (where highest was 107°), to near Regina, Canada. Thence the line turns west to British Columbia and meanders about in a very irregular course through all the far west States and Territories, avoiding the sea coast, however, which has 90 to 100°. The same is true for the bulk of the eastern United States and Canada. In the whole map the lowest maximums are about 94° (at Quebec Halifax, and Buffalo 93°) except in Washington Territory, where the lowest is 85°.

The lines for minimum temperature in the same period, on the contrary, run nearly east and west, showing the usual modifying effect of the sea on the immediate coast. The "zero" minimum runs through Barnegat, N. J., Richmond, Atlanta, Ga., Shreveport, La., and south-central Texas, central Arizona, eastern California and western Oregon and Washington. Eastern Canada shows — 30° to — 40°, Manitoba — 50° to — 60°, and Vancouver's Island — 8°. Providence, New York, Washington, Knoxville and Memphis, have nearly the same minimum of — 10°.

The charts of average variability of daily temperature are also curious. The maximum in January the month of greatest extremes, is 9° in the Dakota-Manitoba region, and thence tapers off in all directions to 5° to 7° along the Atlantic (least in the south) and 2° along the Pacific coast.

The chart of mean annual rainfall for the whole northern hemisphere presents irregularities impossible to summarize, but very curious to study. An area of Asia larger than the whole of North America has the scant rainfall of our far west "desert" districts, and "there is probably no part of the face of the globe where such an enormous area of country is favored with moderate rains—from 30 to 60 ins. per year—as that portion of the United States east of the 97th meridian." The largest rainfall in the world is at Cherrapunji, Assam, India, which is on the side of a precipitous mountain 4,000 ft. high facing the southwest monsoon. It averages 493.2 ins. In August, 1841, 264 ins. or 22 ft. fell, and in 5 successive days 30 ins. per day fell. In 1860, 609.7 ins. (58.3 ft.) fell, and in 1861, 905.1 ins. or 75.5 ft. On June 14, 1876, 40.6 ins. fell, an average of 1.7 ins. per hour for the whole 24 hours.

Gen. GREELY states that the condensation of the entire water in the atmosphere, if saturated at 60°, will produce only 2 ins. of rain, so that excessive rainfalls must always be due to currents of air centering at some one point, and hence be necessarily local.

It is an interesting fact that the May and June rainfall (and to less extent April) is nearly the same (2 to 4 ins.) across the entire northern boundary of the United States, being interrupted by only a short strip at the Rocky Mountains. There is a curious "oasis" of small June rainfall along the north shore of Lake Ontario and the St. Lawrence river.

A chance list of excessive rainfalls on page 147, including 27 instances, are scattered through 15 States and Territories all over the Union, showing that no part of the Union is especially liable to occurrences of that nature.

The data as to "Winds" and "Storms" we must pass over, to speak of the very curious chart of "Tornadoes from 1794 to 1881." The tornado centers in the United States, from which they decrease each way, are 5, viz. 1 near Kansas City and 2 near Springfield, Ill., each of "over 50" in these 97 years; 3 near Binghamton, N. Y., of "over 30"; 4 near Atlanta, Ga., of "over 30," and 5, central Texas with "over 15." In the western half (in area) of the United States, as also in Canada and along our northern boundary, along the immediate sea-coast and along the southern Alleghenies, they are practically unknown.

The center of the "Late Frosts" on the continent is near Winnipeg, at June 1, a fact having an important bearing on the agricultural future of that region. The line of "May 15" passes through Mackinaw, Duluth, well north of Yankton, and thence well north of the Missouri river to a nearly east and west course just south of the boundary line. The line of "May 1" passes through Montreal, Oswego, Buffalo, Detroit, St. Paul, and then turns off southwestwardly. The line of "April 15" passes through Portland, Me., Boston, New York, West Virginia, Louisville, southern Iowa, and then sharply south, and "March 1" lies through the south center of the Gulf States, with Feb. 1 along the Gulf.

With this we must close our review of a book crowded full of facts, many of them of great interest, and all of them discussed by a master of the subject. It will be a handy work of reference to any engineer.

Report of the Massachusetts State Board of Health upon the Sewerage of the Mystic and Charles River Valleys. January, 1889. Senate Publications, No. 2, Boston, Mass., 1889.

This valuable public document contains the Report of the Board, Report of the Consulting Engineer, JOSEPH P. DAVIS, C. E.; Engineer's Report upon the North Metropolitan Sewerage System and Other Sewerage Systems, by HOWARD A. CARSON, C. E.; Reports of the Chief Engineer of the Board, F. P. STEARNS, C. E.; Report upon Sewage disposal by Chemical Precipitation, by CHARLES H. SWAN, C. E., and a report upon experiments upon the Saugus Marshes, by FRED. BROOKS, C. E.

The territory here considered by the State Board of Health includes an area of 130 sq. miles and contains one-sixth of the population of Massachusetts. Some of the cities in this area have more or less complete sewerage systems, discharging on their borders, and thus offensive to themselves and neighbors, while others have little or no sewerage at all. The purpose of the investigation was to devise a system of relief for all these communities, including in this solution of the problem a study of all three of the practical methods of sewage disposal, viz: (1) discharge of the crude sewage into strong tidal currents that will effectively convey it to the sea; (2) filtration by beds; (3) chemical precipitation and discharge of the clarified effluent into outgoing tides.

These several methods were submitted to study and examination by the expert engineers above named. The discharge of crude sewage was examined and reported upon by Mr. CARSON, who concluded that the best outlet for the crude sewage was a little west of the Beacon, about one-third mile south from Deer Island. Mr. PHINEAS BALL, who had charge of the second method of disposal, found that the area recommended by Mass. Drainage Commission of 1885 was the only available territory for treating by filtration any considerable portion of the sewage of the Mystic valley; and Mr. SWAN selected a certain area in Everett as the most favorable point for chemical precipitation. A system of intercepting sewers was designed, and estimates of cost made, for receiving and conveying to each point of disposal the sewage of the towns effected, with a capacity equal to the demands of double the estimated population, or say 300,000 people in 1930. The chief and consulting engineers of the Board submitted a comparative estimate of cost on these three methods of disposal for the above maximum population, as follows: Total first cost of discharging crude sewage at Deer Island Beacon, $2,792,905; total yearly cost, $304,687. Sewage filtration at Saugus Marshes, first cost for 150,000 people, $2,654,636; total yearly cost for same population, $192,795; the area is insufficient for 300,000 population. Chemical précipitation at Island End river, total first cost for 300,000 people, $2,835,651; total yearly, $356,993.

As a result of this comparison, and taking into consideration the cost of chemicals, their application and the removal of sludge with a population greater than 300,000, the Board regards the crude discharge at the point named as the most economical and most certain method. The result found, though not anticipated by the Board, was the more satisfactory as the effluent from chemical precipitation in England has been found to contain nearly one-half of the putrescible material in the sewage. As this material would tend to float on the salt water, in the case under discussion, and would be carried backward and forward by the tides at Boston to such an extent that Mr. SWAN shows that there would always be as much as one and one-half days' sewage in the water about the wharves of Boston, Charlestown, Chelsea, etc., it would be particularly objectionable.

In investigating the disposal by filtration, the ordinary quantity of sewage to be pumped daily was taken at 110 galls. per inhabitant, with a population of 150,000, and 120 galls. daily with 300,000 people. The area required to filter the 36,000,000 galls. from the larger population varies within a very wide range with the character and porosity of the filtering material. Messrs. BALL and BROOKS made for the Board some extended experiments in the Saugus Marshes to learn the quantity that would pass where the surface was kept covered but a short time. Beds 15 ft. in diameter were prepared with under-drains and dikes to prevent overflow. In one of these the turf surface was retained, others had the turf removed for 4 ins. and the surface spaded. The results, arranged in the order of the depth of peat, were as follows:

Depth of Peat in ft.	*Water passing through the surface when continually covered to a depth of 2 ins. In gallons per acre per day.*	
	Natural surface with turf.	*Turf removed and surface spaded.*
1.5	39,000	34,000
1.7	40,000	——
2.1	100,000	32,000
3.5	21,000	23,000
5.0	3,500	3,800

The water in the under-drains was kept from 3½ to 5 ft. below the surface. Experiments were made to note the effect of allowing the surface to remain dry, after each application, for as long a time as it took about two inches of water to disappear. The result of this intermittent application, with intervals of one to two days, was very little increase in the capacity to transmit water. The detail of the further experiments on these peat filters is so interesting that we will return to it again when more space is at our disposal; but the results were so unfavorable in this case that the Board concluded that the Saugus Marshes would not serve for a filtering area, and as no other area was available, sewage disposal by filtration was abandoned.

The report on the North Metropolitan Sewerage System, by Mr. CARSON, is the result of a careful study of the demands of the towns of the Mystic Valley together with Cambridge, Somerville, Charlestown, East Boston and Winthrop. The only reasonably practical method of disposal is the discharge of the crude sewage into the sea, because chemical filtration is too costly and land is wanting for filtering even one-eighth of the sewage. The detail of this report is too local in its nature to permit of any useful review here, other than to point out the difficulties of draining Boston and its suburbs, and the enterprise, care, and engineering intelligence displayed in the radical and costly methods of relief proposed and in part executed. The report of the Board on this head concludes with estimates of cost of the work contemplated as prepared from the detailed estimates in the report submitted. The Board state that these estimates have been carefully prepared and reviewed by the chief and consulting engineers, and as a consequence they present them with confidence.

The estimated cost of the whole work of trunk line and main branches with outlet, with pumping machinery and all details necessary for disposing of the sewage of the North Metropolitan District (with a population of 290,000 in 1892) inclusive of the intercepting sewers of Cambridge, Charlestown, Chelsea, and East Boston, is $4,159,453. The additional expense for disposing of the sewage of 40 years hence, with an estimated population of 513,000, would be increased pumping capacity and additional outlet and syphon pipes, or a total cost for construction to 1930 of $4,383,853. The yearly maintenance, including all running expenses and repairs, would average for 40 years, $100,450.

PUBLICATIONS RECEIVED.

—*Reports on Researches Concerning the Design and Construction of High Masonry Dams, in view of the Proposed Building of the Quaker Bridge Dam.* By R. S. CHURCH, Chief Engineer, A. FTELEY, Consulting Engineer, and a Board of Experts appointed March, 1888, consisting of J. B. DAVIS, J. J. R. CROES, and W. T. SHUNK. Pub. Doc., 4to., pp. 48, 27 plates, 12 tables.

This is a reprint in very handsome and luxurious form of reports which have been already published in full and discussed by us in various issues of 1888. As we have so published and discussed them, and have stated our objections in full to some of the matter contained therein, we will not thresh this straw over again, but content ourselves merely with expressing satisfaction at the favorable features of the report, which are, that the experts' report corrects the section previously approved into one which will be both pleasant to the eye and technically defensible, and that the half million or so of surplus expenditure called for by a defective theory, as we regard it, will not break the city of New York, and will increase, although needlessly, as we hold, the factor of safety of the dam.

—*Report of the Railroad and Warehouse Commissioners of Minnesota*, for the year ending June 30, 1888. HORACE AUSTIN, JOHN L. GIBBS, GEO. L. BECKER, *Commissioners*. 6 x 9 ins., 595 pp.

Some of the matters of special interest in this volume are the action of the Commission in reference to switching rates at Minneapolis, closing upper berths of sleeping cars, milk rates, and local passenger rates. The statistics given we hope to review in an early issue.

—*Intermittent Flush-Tanks.*—Published by the Flush-Tank Co., of Chicago, manufacturers of automatic siphons. Pamphlet, pp 36.

Different types of flush-tanks are described and illustrated, including the Field-Waring, Cuntz, Vibbard and Rhoads-Williams; also a tank for flushing private house drains with sewage from kitchens and baths, and for sub-soil irrigation. Inspection pipes for small sewers are also described. A table of dimensions and prices is given. This company controls the patents covering all siphons operated without moving parts.

—*Annual Report of the Harbor Commissioners of Montreal for 1888.*—The report describes the work done and contemplated, a statement of the shipping, and tables of dredging work and prices. There is also a report on the proposed harbor improvement and flood protection for the central portion of Montreal, by JOHN KENNEDY, Chief Engineer of the Harbor Commissioners, and PERCIVAL W. ST. GEORGE, City Surveyor.

—*Report of State Engineer and Surveyor, of New York.* 1888.—Pamph, pp. 35, with maps and profiles of canals.

—*Report of State Engineer and Surveyor of New York.* 1887.—2 vols. Text and plates.

—*Rose Polytechnic Institute.*—Seventh annual catalogue, with an outline of the course of study and the plan of instruction. 1889. Published by the Institute, Terre Haute, Ind.

—*Report of the Harbor Commissioners of Montreal, for 1888.* Published by the Harbor Commissioners, Montreal, 1889.

This is a useful document, treating of the improvements and proposed improvements in Montreal harbor. The reports of the Chief Engineer, Mr. JOHN KENNEDY, M. Inst. C. E., are particularly full.

—*Annual Statistical Report of the American Iron & Steel Association*, containing complete statistics of the American Iron Trade for 1888 compared with 1887 and a brief Review of the present condition of the Iron Industry in Foreign Countries, JAS. M. SWANK, General Manager. Pamphlet, pp. 80, largely tables. $2.00.

We have reviewed this valuable publication editorially in this issue.

—*Report of the City Engineer of Boston, Mass., for 1888.*

This is a very interesting report. Among the matters of special interest are the illustrated descriptions of the Boylston St. Bridge and Marine Park pier; the matter relating to the destruction of piling by the *limnoria*; the notes on the Mystic Valley sewerage works; and the tests of Gaskill pumping engines at the Chestnut Hill pumping station.

PERSONAL.

Mr. J. BEMUS has been appointed Street and Water Commissioner at Boulder, Col.

Mr. J. B. FELLOWS has been appointed City Engineer and Water Commissioner, at Winona, Minn.

Mr. GEORGE DIXON has been appointed City Engineer of Alton, Ill.

Mr. J. B. CLEMENTS, Assistant Engineer of the Missouri Pacific, has resigned.

Mr. C. M. COOK has been appointed Engineer of Maintenance of Way on the Buffalo, Rochester & Pittsburg.

Mr. J. W. SHERWOOD has been appointed Superintendent of Transportation of the Chesapeake & Ohio and Richmond & Alleghany, with office at Cincinnati, O.

Mr. J. F. QUINN, C. E., of St. Paul, Minn., has gone to Abbotsford, Wis., to take a position on the Wisconsin Central.

Mr. BLAIR BURWELL has been appointed City Engineer of Durango, Col., and Mr. CHAS. BUTLER has been reappointed Superintendent of Water-Works.

Mr. ELWOOD SILBY has been appointed City Engineer of Mankato, Minn.

Mr. JAY GOULD has been elected President of the Texas Pacific Ry. Co., vice Mr. JOHN C. BROWN, resigned.

Mr. A. H. MCALPINE has been re-elected Superintendent and Chief Engineer of the water-works at Columbus, O. Mr. E. L. KEENE is Assistant Superintendent.

Mr. L. H. CRAMER has been appointed Village Engineer at Saratoga Springs, N. Y. Mr. A. D. SEAREY has been appointed Water Commissioner, vice Mr. A. SWANNICK.

Mr. W. G. CURTISS, of Richmond, Ind., has been appointed Superintendent of Water-Works at Alton, Ill., vice Mr. H. A. FULLER, deceased.

Mr. GERECKE, Water-Works Engineer of Chicago, Ill., has resigned. Mr. GERECKE has greatly improved the pumping plant during his term of office.

Mr. ARTHUR THOMAS has been appointed City Engineer of Superior, Wis., at a salary of $1,000 per annum; and Mr. JOHN FINLAYSON has been appointed Street Commissioner, at a salary of $800 per annum.

Mr. JOHNSON N. CAMDEN, Jr., Treasurer of the Ohio River Ry. Co., has resigned to become President of the Parkersburg Construction Co., at Parkersburg, W. Va. He will be succeeded by Mr. WM. TREVOR, formerly Auditor of the road.

Mr. LESLIE A. EMERY, who was a contractor on the Hoosac tunnel, the Boston water-works, New Haven water-works, Washington aqueduct and other works, died April 21 at his home at Dorchester, Mass.

Mr. J. T. ODELL, late of the Chesapeake & Ohio, will, it is said, soon succeed Capt. W. W. PEABODY as General Manager of the Baltimore & Ohio lines west of the Ohio river, the latter resuming his position as Superintendent of the Cincinnati, Washington & Baltimore.

Mr. WILLIAM PHILLIPS, for many years Superintendent of the Lewistown Division of the Pennsylvania Railroad, which runs from Lewistown to Selinsgrove Junction, has resigned to enter into private enterprise. Mr. ROBERT HOLLIDAY, the present Superintendent of the Bedford Division, will succeed him. Mr. W. HEYWARD MEYERS, at present Assistant Engineer of the Philadelphia Division, has been appointed Superintendent of the Bedford Division.

WM. DICKINSON, JOHN W. DICKINSON, JEROME A. KING and IRA C. HUTCHINSON, all of Chicago, Ill., on May 1 formed a partnership under the firm name of Dickinson Bros. & King, and have purchased the assets and business of the Empire Warehouse Co., of Chicago.

VERMEULE & BIEN, Civil and Mining Engineers, have removed their office to No. 71 Broadway, New York Room 128.

Mr. C. B. BENSON, having resigned as General Manager of the Carthage & Adirondack Ry. Co., and Mr. E. A. BOND having resigned as Superintendent and Chief Engineer, the office of General Manager is abolished, and Mr. G. F. HUGGANS is appointed Superintendent and Chief Engineer, with office at Carthage, N. Y. All reports formerly made to Mr. C. B. BENSON as General Manager, or to Mr. E. A. BOND as Superintendent and Chief Engineer, will hereafter be made to Mr. G. F. HUGGANS.

SOCIETY PROCEEDINGS.

American Society of Civil Engineers.—The regular meeting was held May 1, Vice-President A. FTELEY in the chair.

The Secretary announced the death of Mr. CHARLES C. SMITH, M. Am. Soc. C. E., of St. Paul, Minn., on April 19.

Mr. J. J. R. CROES read a communication suggesting that the Society might appropriately take a part in the commemoration of the centenial of the inauguration of GEORGE WASHINGTON as the first President of the United States. WASHINGTON was of a mathematical turn of mind, and in his early life was a land surveyor, the surveying of land being at that time the most important branch of the profession. Specimens of his work in river improvement still exist in Virginia. Had he followed on in this line he would probably have become a prominent civil engineer. It was voted that this communication be entered in the minutes of the Society. Mr. FTELEY stated that he had signed, on behalf of the Society, and in the absence of its president, the memorial presented to President HARRISON on Tuesday by members of the civic, educational and professional bodies. In connection with this matter it was stated that the Society possesses a folding plane table made in 1656 which is said to have belonged to GEORGE WASHINGTON.

The Secretary announced that the convention will be held at Seabright, N. J., beginning about June 20.

A paper on "The Fresh Water Algæ and their Relation to the Purity of Public Water Supplies," was read by Mr. GEO. W. RAFTER, M. Am. Soc. C. E. The paper was interesting, and dealt with an important subject. The discussion was opened by Dr. LEEDS, of the Stevens Institute; but in view of the lateness of the hour, and the importance of the subject, further discussion was postponed until the next meeting, May 15. After the meeting the members present viewed with interest microscopic specimens of algæ exhibited by Mr. RAFTER and Mr. DUDLEY. We shall publish an abstract of this paper next week, and as it deals with a subject in which all water-works men are interested, it will probably lead to considerable discussion.

The following candidates were declared elected:

MEMBERS.

CHARLES J. BATES, New York City.

CORNELIUS C. F. BENT, Supt. Ohio & Mississippi Ry., Cincinnati, O.

CHARLES T. CHURCH, Chf. Eng. Housatonic Ry. and New Haven & Derby Ry., Saratoga Springs, N. Y.

CHARLES S. CHURCHILL, Eng. M. of Way, Norfolk & Western Ry., Roanoke, Va.

HARRY FRAZIER, Roadmaster Henderson Div., L. & N. Ry., Hopkinsville, Ky.

GEORGE P. HILTON, Eng. Hilton Bridge Const. Co., Albany, N. Y.

HOWARD G. KELLY, Res. Eng. St. Louis, Arkansas & Texas Ry., Texarkana, Tex.

FRANK O. MAXSON, Civ. Eng. U. S. N., Washington, D. C.

GEO. N. MERRILL, Res. Eng. Poughkeepsie & Connecticut Ry., Stanfordville, N. Y.

ANDREW W. MUNSTER, City Engineer's Office, St. Paul, Minn.

JOSEPH RAMSEY, Jr., Chf. Eng. Cincinnati, Hamilton & Dayton Ry., Cincinnati, O.

JAMES E. WILLARD, Supt. of Const., with Sooysmith & Co., West Point, Ky.

ASSOCIATE.

WM. L. ABBOTT, of Carnegie, Phipps & Co., Pittsburg, Pa.

JUNIORS.

JOHN N. H. CORNELL, New Croton Aqueduct, New York City.

WILL E. CRANE, Lassig Bridge & Iron Works, Pittsburg, Pa.

ALFRED B. ELLSWORTH, Pittsburg Testing Laboratory, Pittsburg, Pa.

OSCAR ERLANDSEN, Asst. Eng. Union Bridge Co., Poughkeepsie, N. Y.

WM. L. FERGUSON, Philadelphia, Pa.

Engineers' Club of Philadelphia.—The regular meeting was held April 20; Vice-President, ARTHUR BEARDSLEY in the chair: 24 members present.

The Secretary presented, for Mr. SAMUEL TOBIAS WAGNER, a copy of a letter which he had written to ENGINEERING NEWS on the subject of "Standard Rivet Symbols." The letter appears in ENGINEERING NEWS of March 23, 1889, p. 266.

The Secretary presented, for Mr. HENRY A. VEZIN, an illustrated description of "Gallows Frames in Colorado," Mr VEZIN says:

"By mail you will receive 6 tracings. They are designs of gallows frames at mines near Leadville. Two show the frames at the Satellite and Star of the West mines; 2 show the frame of the Wright shaft, Lee Basin mine, as built; 2 others show the first plans for the Wright shaft, which were slightly modified. The sketch for the iron frame was made because the manager insisted on having an iron frame as a safeguard against fire. He did not seem to understand that the burning of the old frame was due to the burning of the shaft-house, that a wooden gallows frame cannot burn by itself, and that an iron frame would be destroyed should the shaft-house burn. The plan of using iron was abandoned when it was found that the iron frame would cost at least three times as much as the wooden one.

"The gallows frames usually made in the West have heavy timbers resting on the collar of the shaft with comparatively light struts in the direction of the pull. They have many mortices and tenons, much cross-bracing and many points of vibration. In these that I send the timbers are subjected to end thrust only, the tie rods to tension. There are no mortices and tenons, no nice work, much less timber is used, the posts and strut leave the collar of the shaft clear, and the frames are unusually stiff. The main struts or posts are placed in the line of the resultant of the pulls on the rope. At the Star of the West mine the hoisting engine was placed so far from the shaft that the resultant exerted an upward strain on the frame. It was not as great as the weight of sheave and frame, but, as an extra precaution, so as to allow for placing the engine much further from the shaft, the 8 x 8 front struts were tied to the sills and to the main posts.

"The Wright shaft gallows frame cost $65 for framing and erecting, at which price the men lost money. Wages were $4 and $5 per day for millwrights. Bids by men of better judgment were $136 to $150. I am under the impression that the whole frame cost $400, lumber being $22 per thousand. The original frame had 4 posts, 18 x 22 ins., was framed like those of the Comstock mine and cost $1,800. The timber then cost $35 per thousand."

Prof. H. W. SPANGLER described an instrument for summing up the lengths of lines, consisting of a pair of dividers with a registering device attached. He explained its use in determining the area of indicator cards, by dividing the card into vertical trapezoids of equal width, obtaining the aggregate of the average height of each with these dividers, and multiplying by the width.

HOWARD MURPHY,
Secretary and Treasurer.

American Society of Mechanical Engineers.—The 19th meeting will be held at Erie, Pa., May 14, 15, 16 and 17. The headquarters will be at the Reed House, and the sessions will be held at the Board of Trade chamber. The first session will be on the evening of Tuesday, May 14, when there will be an address by ex-President HORACE SEE, followed by a social reunion.

On Wednesday morning, May 15, business will be transacted, and the following papers presented for discussion: "The Piping of Steel Ingots," THOS. S. CRANE; "Gain Sharing," HENRY R. TOWNE; "Comparative Cost of Steam and Water," CHAS. H. MANNING; "The Old Locomotive 'Sampson,'" D. W. ROBB; "Standards," JAMES W. SEE. In the afternoon the party will visit the Erie City Iron Works and the works of the Stearns Mfg. Co. In the evening the following papers will be presented: "Notes on the Comparative Loss by Friction in a Transmitting Dynamometer under Different Loads and Speeds," SAMUEL WEBBER; "Note on the Steam Turbine," and "An Error in the Encyclopædia Britannica," J. BURKITT WEBB; "Steam Consumption by Engines at Various Speeds," JAS. E. DENTON and D. S. JACOBUS; "Performance of a 35-ton Ice Machine," JAS. E. DENTON. Topical discussions will close the session.

On Thursday morning, May 16, the following paper will be presented: "Expansion of Timber Due to Absorption of Water," "Some Properties of Ammonia," "Formulas for Saturated and Superheated Vapors," and "Some Properties of Vapor and Vapor Engines," all by DE VOLSON WOOD; "Cornish or Double-Beat Pump Valves," A. F. NAGLE; "Improved Motion Device for Engine Indicators," A. W. JACOBI; "Distribution of Steam in the Strong Locomotive" (supplement), F. W DEAN; "Cylinder Ratios, in Triple Expansion Engines," JAY M. WHITHAM. Topical discussions will follow. In the afternoon visits will be paid to several engine and manufacturing works. In the evening there will be a reception.

On Friday morning, May 17, the following papers will be presented: "Belt Traction on Pulley Faces," SCOTT A. SMITH; "On the Longitudinal Riveted Joints of Steam Boiler Shells," JOHN H. COOPER; "Bits of Engine-Room Experience," and "Kerosene Oil in Steam Boilers" (supplement), LEWIS F. LYNE. After topical discussions and concluding business, the meeting will adjourn. In the afternoon there will be a trip on the lake, a visit to the Erie water-works and the life-saving station on Presque Isle.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Chicago, Kalamazoo & Saginaw.—Work on the grading for the extension of this Michigan road was begun at a point north of Woodland on April 25. The grading from Hastings to Woodland is already completed and the track will be laid soon.

New York, Lake Erie & Western.—There is quite a pressure being exerted to induce the company to double track the Orange branch of the Greenwood Lake railway and extend it to South Orange. Surveys are now being made under direction of prominent residents of Orange.

Lincoln Park & Charlotte.—Grading for this new road, near Rochester, N. Y., is about half finished, and tracklaying is soon to begin.

Louisville, New Albany & Chicago.—Much interest is felt in the proposed short line from Louisville to Indianapolis, and a large amount of local aid has been proffered.

Philadelphia & Reading.—The $80,000 subscription asked in aid of the extension of the Northeast Pennsylvania R. R., from Hartsville to New Hope, on the Delaware river, is nearly raised. It is stated that one main object of the company in building this extension is to

secure a new freight route to New York. The Delaware will be bridged at New Hope, and the line will be pushed on to Flemington, N. J., where connection will be made with the Central Railroad of New Jersey system. The new extension will greatly relieve the pressure on the tracks of the Bound Brook line.——No contract has yet been given out for the road from Winslow Junction, N. J., on the Atlantic City R. R., to Cape May and Sea Isle City. The branch is likely to be built at an early day, however.

Cleveland & Canton.—Tracklaying is in progress along the line of the Coshocton & Southern railway. Some trouble over the right of way through Dresden has arisen. The company put down the rails by night, but an injunction has been issued restraining them from running trains over the track.

New York, Ontario & Western.—The company has filed a $10,000,000 mortgage to the Mercantile Trust Co., of this city, to raise funds for the extension to Scranton, Pa., and for other contemplated improvements.

Central Railroad of New Jersey.—E. P. STACEY, of Philadelphia, is quoted as stating that work on the Baltimore & Delaware Bay extension to Tolchester will be pushed at once. Contracts for the rails and for building piers at Bombay Hook have been let. A line of steamers will be run in connection with the road directly from Tolchester to Baltimore.

St. Joseph Valley.—J. BURNS, of Goshen, Ind., has bought this Michigan road and will change it to standard gauge, and extend it to Goshen.

New Hampshire.—A correspondent of the Boston *Journal* gives the following account of New Hampshire railway extensions:

The Whitefield & Jefferson road has several miles of extension nearly ready for the rails, and arrangements are nearly closed for securing capital to push the line on to Gorham and thence up the Androscoggin valley to a connection eventually with Canadian lines. The Kilkenny lumber road, running from Lancaster east 10 miles, is being extended toward the Grand Trunk, which it will probably join at Berlin. Littleton parties are moving to secure a line to Franconia, 6 miles, and it is proposed to extend it to a connection with the Pemigewasset Valley road at North Woodstock. The old project for an extension of this latter road to Fabyan's is again agitated and may be carried out this season. The Bartlett & Albany lumber line is working toward a future terminus at Conway. In the extreme northern wilderness a preliminary survey has been made for a line from West Stewartstown to the Connecticut lakes.

Lake Shore & Michigan Southern.—The annual report shows the following results of operations for 1888:

	1888	1887
Gross earnings	$18,029,627	$18,710,963
Operating expenses	11,3.0,371	11,023,799
Net earnings	6,719,256	7,681,164

The net earnings of the New York, Chicago & St. Louis (Nickel Plate) for 1888 were $722,978, against $1,167,474 the year before.

Toledo, Ann Arbor & North Michigan.—The annual report of this Michigan company shows the gross earnings for 1888 to have been $687,579, and operating expenses, $433,392. During the year the road was relaid with 56-lb. steel rails. It is the intention of the company to occupy the territory west and north of Cadillac, and when the system is complete it will consist of 460 miles of road, crossing every trunk line in Michigan. At the Lake Michigan terminus a large iron plant will be established for the manufacture of charcoal pig iron from Escanaba ores.

Flint & Pere Marquette.—The annual report of this company shows as follows:

	1888	1887
Gross earnings	$2,403,074	$2,572,997
Net earnings	756,650	757,654

Evansville & Terre Haute.—D. J. MACKEY is considering the project for a belt railway at Seymour, Ind.

Western Maryland.—President J. M. HOOD announces that the extension from Blue Ridge Summit to near Gettysburg, Pa., the old "Tapeworm" Railroad, will be open for travel by May 20. The route was surveyed and the line was partly graded a half century ago by the late THADDEUS STEVENS; but on account of the many curves it was abandoned.

Philadelphia & Reading.—The extension of the Mt. Ephraim R. R., will be about 12 miles in length, from Mt. Ephraim to Glassboro, where connection will be made with the Williamstown & Delaware River R. R. and thus with the New Jersey Southern.——Right of way and local aid are being secured for the proposed line to Cape May and Sea Isle City.

Pennsylvania.—Work on the addition to the Broad St. Station at Philadelphia has been postponed for some months.

Housatonic.—The majority report of the Committee of the Connecticut Legislature, regarding the capitalization of this company says, after a review of the facts as found:

Your committee can but express decidedly their condemnation of the manner in which the accounts of the Housatonic Railroad Co. have been written up.

Projects and Surveys.

Canada.—The Dominion Parliament has granted cash subsidies to the following railway companies:

For a line from Joggins' Railway to Young's Mills, 5 miles, $16,000; St. Clair Frontier Tunnel Co., for a tunnel from Sarnia to Port Huron, $375,000; Pontiac & Renfrew, for a line from the Ottawa river to the Pontiac Pacific Junction Ry., 6 miles, $19,200; Quebec, Montemoring & Charlevois, 30 miles: from St. Catharines river to Cape Tourment, $96,000; Fredericton & St. Mary's Bridge Co., for a bridge over St. Johns river, at Fredericton, $30,000; Napanee, Tamworth & Quebec, from New Moose to Harrowsmith, $32,000; Cornwall Valley, from the end of the present subsidized line to Kingsford, N. S., $3,200; for a line from Sicamores, on the Canadian Pacific to Lake Okangar, 51 miles, $163,200; to the Lake Temiscamingue Colonization, 15 miles, from Mattawa towards the Long Sault, $48,000; Muskinonge & Lake Nippissing, from Muskinonge towards the Mattawa river, 15 miles, $48,000; Kingston & Smith's Falls, from Kingston towards Smith's Falls, $64,000; South Ontario & Pacific, for 49¼ miles, from Woodstock to Hamilton, $158,400; for a line from St. Cesaire to St. Paul de Abbottsford, 5 miles, $16,000; to the Great Eastern, from St. Gregorie towards the Chaudiere Junction Station, on the Intercolonial Ry., $64,000; Drummond County, from the end of the present subsidized line to Ball's Wharf, on the St. Lawrence river, $14,400; St. Catharines & Niagara Central, from St. Catharines towards the city of Hamilton, $64,000; Grand Trunk & Georgian Bay, 15 miles, from Tara to Owen Sound, $48,000; Hereford, from Cookshire to the Quebec Central at Dudsville, 15 miles, $48,000; Massawippi Junction, from Ayer's Flat to Coaticoke, $48,000; Brockville, Westport & Sault Ste. Marie, from Westport to Placer Rapids, 20 miles, $64,000; Thousand Islands R'y., for a line from the St. Lawrence river via Ganan Junction, on the Grand Trunk, to the Brockville, Westport & Sault Ste. Marie R.R., $54,400; for a railway from Cape Tourment towards Murray Bay, 20 miles, $64,000, and to the Amhurstburg & Lake Shore Ry., for 20 miles, $3,200 per mile.

Neversink Valley.—Incorporated in New York to build a railway from Fallsburg Station on the New York, Ontario & Western R. R. to the village of Neversink, about 15 miles. The locating surveys have been completed and right of way is being secured. The officers of the company are: WM. B. ROYCE, President; JOHN W. LOW, Vice-President; CHAS. H. MAPES, Treasurer, and THOS. WATTS, Secretary; all of Middletown, N. Y.

Ohio & West Virginia Southern.—Incorporated in Ohio to build a line of railway from Marietta, O., through the counties of Wood, Pleasant, Braxton, Webster and Pocahantas, to a connection with the West Virginia system of railways to the seaboard. Among the incorporators are R. R. DAWS, W. M. MORSE, and W. H. GURLEY, of Marietta.

Cincinnati & Ohio River.—Chartered in Ohio by F. G. CROSS, A. H. MATTOX, C. B. MATTHEWS, and CHARLES M. HEPBURN to build a line of railway from Gallipolis to a point on the Dayton, Ft. Wayne & Chicago R. R., in Gallia county, or a point on the Cincinnati, Washington & Baltimore R. R., near Oak Hill, Jackson county, about 23 miles. The United Coal, Coke & Iron Co., of Cincinnati, has been incorporated in connection with the railway. The object of the two companies is to open up the coal fields in Jackson and Gallia counties.

Confluence & State Line.—Incorporated in Pennsylvania to build a railway from a point near Confluence to a point on the Maryland State line, a distance of 10 miles. J. BAYARD HENRY, of Germantown, Pa., is President.

Sandusky, Lake Erie & Southern Short Line.—JOHN MCKELVIE, HENRY C. HUNTINGTON, DAVID KUNTZ, and others of Ohio, have incorporated a railway company by this name. It is stated that the road is intended to be an outlet to the Great Lakes for the Chesapeake & Ohio Ry. system.

Delaware.—The bills before the Delaware Legislature to incorporate the Citizens' R. R. Co., the Harrington & Breakwater R. R. Co., and the Georgetown, Milton & Breakwater R. R. Co., have been defeated in the lower house.

SOUTHERN.—Existing Roads.

Cincinnati, Alabama & Atlantic.—Mr. M. R. CAMPBELL, of Tullahoma, Tenn., president of this company sends us the following information:

Engineers are now making the permanent location for this road, which is projected to run from Huntsville, Ala., via Fayetteville, Lynchburg, Tullahoma, Woodbury, Cookeville, Livingston, Birdstown, in Tennessee, Auburn, and Monticello, to Somerset, Ky., a distance of 260 miles. The work is considered heavy as compared with most Southern roads. The maximum grades are 75 ft. per mile and curves are 8°. There will be two large bridges and about five short tunnels. Along the line of the road there are billions of feet of the best hard woods and yellow popiar, seams of coal, iron ore deposits suitable for steel making, oil, natural gas, lithographic stone, lead, silver, and marble. For fully half the distance the line runs through a good agricultural region. No railroad in the United States has such a great variety of mineral and timber wealth; and there is a present population on the line of 1,668 per mile.

The contract has been let for constructing the entire line, and 116 miles are to be completed by June 1, 1890. About 148 miles of right of way is secured and nearly $600,000 local aid has been obtained in the shape of town, county, and individual subscriptions in addition to rights of way in exchange for stock in the company. The road is chartered in three States and is an independent line. We will probably begin tracklaying by October 1, next, and the first section will be open for traffic by March 1, 1890. O. H. P. CORNELL, of New York City, is Chief Engineer with headquarters at Tullahoma, Tenn.

Louisville, New Orleans & Texas.—The company is considering an extension of the Lake Washington branch. One plan is to build to a junction with the main line at Rolling Fork. It is also proposed to build on down to the vicinity of Vicksburg. Surveys are in progress for the terminal tracks at Helena, Ark.

Tennessee Midland.—The tracklayers on this Tennessee road have reached Parson's, 6 miles west of Perryville, Tenn.

Marietta & North Georgia.—The work of changing this road to standard gauge will be completed by May 1.

Craig Mineral.—The surveyors on this Virginia road are working near New Castle. A satisfactory grade has been obtained, but the work will be quite heavy.

Farmville & Powhatan.—Grading has been completed on this Virginia road and tracklaying is to be pushed at once so that the line may be open for business early in July.

East Tennessee, Virginia & Georgia.—It is reported that a corps of surveyors has been put in the field to make the final location of a branch from a point near Briarfield, Ala., through the Cahaba coal field, along the valley of the Cahaba river. The work will be under the charge of Col. CARY A. WILSON.

Columbus Southern.—It is reported that this Georgia road, now being graded from Columbus to Albany, Ga., will be run in connection with the Florida Railway & Navigation Company's system. Work is to be pushed on the line as fast as possible.

Baltimore & Ohio.—Surveyors are reported at work on a line from Cairo, Ritchie county, W. Va., to Grantville, Calhoun county, about 35 miles.

Nashville & Knoxville.—Regular trains are now running from Lebanon to Carthage, 75 miles east of Knoxville, Tenn., and the road is finished to the Caney Fork river, 8 miles beyond Carthage Junction, where a steel bridge with a draw span is now under construction. From the river to Cookeville, 21 miles, the road is already nearly graded and trains will be running over it in early fall. The road is being built by A. L. CRAWFORD, of Newcastle, Pa. From Cookeville the road is to be built on east to a connection with the Cincinnati Southern at Hickman or Lancaster in Smith county, about 60 miles, tapping on the way valuable coal lands, over 50,000 acres in extent, owned by Mr. CRAWFORD. Surveys have been made for this portion of the road, but the route has not yet been decided upon.

Chattanooga, Rome & Columbus.—President WILLIAMSON has made a formal offer to the directors of the Savannah, Griffin & North Alabama Railroad, extending from Carrollton to Griffin, Ga., to lease this road, which is now operated as part of the Central Railroad of Georgia system, for a rental consisting of the interest on its bonds and 2 per cent. on its capital stock. If the offer is accepted, President WILLIAMSON agrees to see that the branch of the Covington & Macon from Monticello to Griffin, is finished within 6 months from the date of the lease; and he states that traffic agreements will be made with the Covington & Macon and the Georgia Southern & Florida roads, by which a through line will be established from Chattanooga to Florida via Griffin, Monticello and Macon.

Savannah, Dublin & Western Short Line.—The property of this bankrupt Georgia company, consisting of the franchise, right-of-way and partly graded roadbed of a projected railway from a point near Savannah, west to Dublin and Americus, Ga., is to be sold to the highest bidder on June 4, 1889, at Savannah by the Receiver, RICHARD J. DAVANT. An upset price of $50,000 has been fixed by the Court.

Decatur, Chesapeake & New Orleans.—The contract for constructing this road has been let to Belden & McTighe, of New York City, who are letting out contracts all along the line. The Alabama and Tennessee divisions have been consolidated and the following directors have been elected: H. G. BOND and E. C. GORDON, Decatur, Ala.; G. W. EDWARDS, New York City; J. G. HOLMES, S. W. RAWLS, G. W. MORGAN, of Lincoln county, Tenn.; G. C. SANDUSKY, and W. O. FROST, of Bedford county, Tenn. W. G. EDWARDS is in charge of the work with headquarters at Fayetteville.

West Virginia Central.—The tracklayers reached Montrose on April 26.

Louisville & Nashville.—The preliminary survey for the branch to Tuscaloosa, Ala., noted last week, has been completed, and a favorable route has been secured.

Roanoke & Southern.—A $15,000 subscription is being raised at Roanoke, Va., to enable work to be started on the Northern division of this road.

Queen & Crescent.—Baron ERLANGER, who has been taking a trip over this system, in which he is largely interested, is quoted as follows in reference to projected extensions:

We did discuss several projects, but none of them are sufficiently developed to warrant me in making them public. There has got to be continual building in the way of connections and new lines, but anything we did I must in fairness first submit to my London associates, for their approval before making public.

Is it true that you have been dissatisfied with the management of the roads and your investment? was asked.

Well, it has been a long fight and a hard one. For a long time we have worked uphill. We know all along

that we were placing a great deal of money into something we had never seen, and that the return was not what the capital invested warranted. Now, however, I think we have turned the corner, and I am entirely satisfied with the outlook.

Georgia Pacific.—On the extension across the State of Mississippi, grading is about completed from Greenwood to Johnsonville, 142 miles, about 85 miles of track has been laid and the remainder is being rapidly put in place. It is expected that the whole line to the Mississippi river will be in operation by July 10.

Projects and Surve

Mexican Gulf, Pacific & Puget Sound.—We have received the following information concerning this enterprise from S. N. VAN PRAAG, of Pensacola, Fla.:

This road is projected to run from Pensacola, Fla., to the Pacific coast, with a branch from some point on the main line between Pensacola and San Francisco to Puget Sound. The road is to be built in co operation with other railway corporations.——The Pensacola & Memphis Terminal R. R. Co. has also been incorporated by me, and is intended to furnish terminal facilities for the Pensacola & Memphis R. R.

Dover & Statesboro.—Application has been made by this company to the Secretary of State for an extension south from Way Cross, Ga., to a point on the Savannah river in Screven county and north from Dover, Ga., 25 miles. FREDERICK LOCKHART, of Augusta, is president.

Meridian Belt.—J. M. T. HAMILTON, of Meridian, Miss., Chief Engineer, gives us the following information concerning this enterprise:

The surveys for this road, which is to be a belt line transfer around the city of Meridian, will begin about May 1. There will be about 10 miles of main line, and two branches, 1 mile each. The line is built in the interest of the city of Meridian, and the principal business will be in the transfer of cars and suburban passengers. Good progress has been made in obtaining right of way.

Montgomery & Meridian.—Incorporated in Alabama to build a line of railway from Montgomery, Ala., to Meridian, Miss., a distance of about 200 miles. Surveys will commence at once.

Pinellas Belt.—Incorporated in Florida to build a railway from Poppy's Bayou to Disto n. The road is to be completed in 12 months.

Coal Creek & Beech Fork.—T. H. HEALD, of Knoxville, Tenn., President, writes as follows:

This road is to run from Coal Creek, Anderson county, to New river on the Cincinnati Southern R. R., a distance of 35 miles. The route is through a country rich in timber, coal and ore, and the object of the road is to open up this region to the Cincinnati Southern R. R.

Asheville & Bristol.—A project is on foot to build a line of railway from Asheville, N. C., to Bristol, Tenn., a distance of about 83 miles. Col. T. COLEMAN, of Asheville, is Chief Engineer.

Oviedo, Lake Charm & Lake Jessup.—Incorporated in Florida to build a line of railway 3½ miles long. The capital stock is $50,000.

St. John's, Lake Weir & Gulf.—The right of way for this road, which is to run from Oxford, Fla., to Lake Weir, has been obtained, and it is stated that construction will begin at once.

Savannah & Oconee.—Incorporated in Georgia by HORACE P. SMARTT, D. C. BACON, M. F. ARMSTRONG, and others, of Savannah, to build a railway from Savannah to the Oconee river, a distance of 100 miles.

Cleveland.—W. B. BELL, of Cleveland, Ga., sends us information concerning this enterprise as follows:

This company has just organized to build a line of railway 17 miles long, running from Cleveland to a connection with the Northeastern R. R. of Georgia, at Lula. The work will be easy. There will be one bridge about 150 ft. long. The principal business of the road will be in agricultural products and stock. Right of way will be granted and it is expected that other local aid will be obtained from the people along the route.

Athens & Jefferson.—The officers of this Georgia road are: President, R. B. RUSSELL; Secretary, R. L. MOSS, and Treasurer, JOHN A. HUNNICUTT. The road is projected to run from Athens to Jefferson, 18½ miles.

THE NORTHWEST.—Existing Roads.

Alton Terminal.—H. A. FISHER, of St. Louis, Mo., Vice-President and General Manager, writes us that 1 mile of track has already been laid on this road and that 1½ miles more will be built this season. DELOS R. HAYNES, of St. Louis, is President.

Northern Pacific & Manitoba.—The locating surveys for the branch from Morris to Brandon have been completed for a distance of 125 miles. Contracts for construction will be let soon and the work be rapidly pushed to completion.

West Duluth Incline.—It is reported that work has begun on this road, which is to run from a point on the St. Paul & Duluth R. R. between West Duluth and West End Station to the summit of the hill about one mile north of West End, a distance of 1¼ miles. It is expected to have the road completed by Sept. 1, 1889.

Projects and Surveys.

Manitoba.—The Dominion Parliament has granted the following railway subsidies: To the Northwest Coal & Navigation Co., a subsidy of 2,000 acres of land per mile from Dunmore Station to Lethbridge, on the condition that the road be changed to standard gauge between these two points; and a subsidy of 6,400 acres per mile for an extension from Lethbridge to the International boundary; to the Red Deer Valley, a subsidy of 6,400 acres per mile; to the Qu'Appelle, Long Lake & Saskatchewan, a subsidy of 6,400 acres per mile, from Long Lake to Prince Albert, and to the Manitoba Ry. & Canal Co., 6,400 acres per mile, from Portage la Prairie to the southern boundary of Lake Manitoba.

Centralia & Altamont.—Incorporated in Illinois to build a line of railway from Centralia, Marion county, to Altamont, Effingham county, a distance of about 40 miles. Among the incorporators are LEWIS F. CASEY, G. P. DUNCAN, A. DUNKER, and JACOB GROSCH, all of Centralia, where the principal offices of the company will be established.

Yankton & Norfolk.—The city of Norfolk, Neb., has voted the $30,000 of bonds asked by this company in aid of its enterprise and the surveys will begin at once. The officers of the company are: JAMES H. TELLER, of Yankton, President; CHARLES G. HALE, of London, Eng., Vice-President, and J. G. M. PIERCE, of Yankton, Secretary.

Wisconsin Midland.—It is announced that the prospects are good for obtaining the money to build this Wisconsin road. Several Michigan capitalists have been interested in the enterprise.

Omaha & Yankton.—A project is being agitated to build a railway from Yankton, Dak., to Omaha, Neb. GEO. L. MILLER, FRANK MURPHY, and others, of Omaha, are interested.

Abbotsford & Northeastern.—Incorporated in Wisconsin to build a line of railway from Abbotsford station on the Wisconsin Central R. R., to Black Creek Falls, Marathon county, a distance of 15 miles. Among the incorporators are ALFRED A. KROUSE, ANDREW M. JOYS, JOSEPH E. HOST, and others, of Milwaukee, Wis.

St. Louis, Quincy, Omaha & Sioux City.—It is reported that arrangements have been made whereby the funds necessary for the construction of this road have been obtained. It is proposed to secure trackage facilities from St. Louis to Hannibal, a distance of 126 miles. From Hannibal to West Quincy, 20 miles, the company will build; and from West Quincy to Trenton, Mo., 134 miles, a complete line will be purchased. From there to Sioux City, a distance of about 225 miles, a new line will be built. F. B. STEARNS, of New York, is President.

THE SOUTHWEST.—Existing Roads.

Louisville, New Orleans & Texas.—J. W. GRAVES, of Slaughter, La., writes us that the grading on the Bayou Sara branch of this road is completed. Tracklaying began April 23, and the company expects to have trains running from Slaughter to Bayou Sara by June 1. Capt. W. W. HAYDEN is the engineer in charge, with headquarters at Slaughter.

Dodge City, Montezuma & Trinidad.—It is stated that work will be commenced on the extension of this road from Montezuma, Kan., to Trinidad, Col., within 40 days, and the road be completed by Oct. 1. The road was completed from Dodge City to Montezuma, 28 miles, last season. W. W. MUNSELL, of Dodge City, Kan., is Secretary.

Wabash Western.—The citizens of Columbia, Glasgow, Fayette, and other Missouri towns are taking steps to secure the extension of the Columbia branch of this road to Glasgow, a distance of about 35 miles. The road would run through a rich farming country, with valuable coal deposits, which is now lacking in railway facilities.

Dallas, Pacific & Southeastern.—Twenty-seven miles of grading on this road has been completed, and work is progressing at the rate of 1 mile a day.

St. Louis, Arkansas & Texas.—The annual report of this company shows as follows:

	1888.	1887.
Gross earnings	$3,072,348	$2,670,531
Expenses	3,050,422	1,905,743

Of the above outlay, maintenance of way cost $687,166, as compared with $345,509 for maintenance in 1887. The cost of motive power for 1888 was $872,768, as compared with $576,201 for 1887. The conduct of transportation cost $1,048,604 for 1888, as compared with $715,545 for 1887. A small surplus of $21,925 is presented, however, as the result of the operations of the year.

The system has a mileage of 509 miles in Arkansas and Missouri, and 701 miles in Texas—1,300 miles in all. The only portion that is narrow-gauge is the section of 85 miles between Tyler and Lufkin.

Projects and Surveys.

Reed Springs & Kansas City.—We have received the following information from SAMUEL HARDWICKE, of Liberty, Mo.:

The surveys for this road, which is to run from Liberty to Birmingham, a distance of 4 miles, have commenced. The road will ultimately be extended to Kansas City. The line as proposed affords easy grades and light work. The principal business of the road will be the transportation of minerals from the mines now in operation near Randolph and the general freight traffic to and from Liberty and Reed Springs, both of which are thriving manufacturing towns. The right of way has been given and considerable other local aid obtained from the towns along the route.

It is expected that contracts will be let about May 20. The company was incorporated March 28, 1889. GEO. I. REED is President and GUSTAVE DAYES is Chief Engineer.

Lampasas, Burnet & Southwestern.—The preliminary surveys are in progress on this road under the direction of Chief Engineer H. L. HIGDON.

Fort Worth & Albuquerque.—The Fort Worth Construction Co., of which W. F. SOMMERVILLE, of Fort Worth, Tex., is President, and M. C. HURLEY, of Fort Worth, Vice-President, has made arrangements to begin work on the construction of this road at once.

Kansas City, Louisiana & Gulf.—The officers of this company are: J. P. POMEROY, President; H. M. JACKSON, Vice-President; GEO. W. SIMMONDS, Secretary: M. T. FRAME, General Manager, and J. H. DAWSON, Chief Engineer. The road is to run from Lake Charles, La., to Alexandria, La. It is stated that the locating surveys have begun, and that the money necessary to build the greater part of the line is on hand.

New Birmingham & Northwestern.—Incorporated in Texas to build a line of railway from New Birmingham to a point on the International & Great Northern R. R.

North Louisiana & Arkansas.—This company has been chartered in Louisiana to build from Bastrop to Girard, a distance of 20 miles.

ROCKY MT. AND PAC.—Existing Roads.

Redondo.—A correspondent furnishes us the following information concerning this enterprise.

The surveys for this road, 22 miles in length, have been completed, and the right of way is all obtained. The route is through a level or rolling prairie country. The principal business will be the ocean freight and passenger traffic of tourists and health seekers. The road will connect with the Rapid Transit and Carson & Colorado Railways. It is expected that tracklaying will begin about the first of May and the road be opened for traffic about July 1. The company was incorporated April 1, 1889. GEO. J. AINSWORTH is President, L. FRIEL, Chief Engineer and S. O. BROWN, Vice-President and General Manager; all of Los Angeles, Cal.

Southern Pacific.—A press dispatch quotes Vice-President C. P. HUNTINGTON as saying that this company will extend the Coast Line from Santa Margarita to San Luis Obispo, a distance of 16 miles, at once. It is announced that contracts have been let for building a road from Logansport, La., to Carthage, Tex., a distance of about 25 miles. The line will ultimately be extended from Logansport to Cheneyville, La., a distance of about 120 miles.

Denver & Rio Grande.—The annual report of this company for 1888 shows the following results of operations as compared with the previous year:

	1888.	1887.
Gross earnings	$7,668,654	$7,983,419
Operating expenses	5,104,681	4,742,048
Net	2,563,973	3,241,371

The tonnage in 1888 was 1,720,670 tons against 1,694,207 tons in 1887. Freight rates were 2.19 cts. in 1888 against 2.39 cts. in 1887. Passengers carried in 1888 were 569,156 against 606,988 in 1887. Passenger rates 2.79 cts. in 1888 against 3.09 cts. in 1887. During the year $240,906 was expended in betterments.

Union Pacific.—The order to cease work on the Cheyenne & Northern R. R. has been countermanded and the work will be continued. The extension runs from Wendover to Douglas, Wyo., a distance of 40 miles. The surveys have been made and a large amount of material is on hand ready for the commencement of operations.

Bellingham Bay & British Columbia.—This company expects to commence work on its road about the first of May. About 3½ miles of the main line is now completed and grading has been finished on about 6 miles more. A logging branch from the main line to Lake Whatcom will also be built this season. P. B. CORNWALL is President and M. D. STANGROOM is General Manager; both of Whatcom, W. T.

Bellingham Bay Railway & Navigation Co.—About 700 men are now at work clearing and grading the line between New Westminister and Whatcom, about 44 miles. Arrangements have been made for rails, ties, piling and bridge timbers, and the contracts for the construction of the bridge and the road will be let immediately. EUGENE CANFIELD is President, and CHARLES KING is General Manager; both of Seattle, W. T.

Ilwaco & Shoalwater Bay.—A press report states that the extension of this road between Ilwaco and Sea Land, the new terminus, is rapidly nearing completion. The grading is all finished and track has been laid for a distance of 15 miles. It is expected that the entire 20 miles will be open for traffic by May 20.

Northern Pacific.—A press report announces that work will soon be begun on an extension of the Central Washington R. R. from Davenport west. The road will be built from Davenport through the Grand Coulee to Waterville this year. It will then be extended from Waterville across the Columbia river and along the Wenatchee Valley to Cle Elum, joining the present branch to that place. The Cle Elum branch has already been extended 12 miles to the mines this year, and this new track will be used.

San Diego & Eastern.—The contract for grading the first 4½ miles of this road has been let to E. C. BURLINGAME, of Los Angeles, Cal. Work is to commence at once and the grading will be completed in 30 days. The rails and other material are on hand and track-laying will begin as soon as grading is completed.

Projects and Surveys.

Tacoma & Lake City.—It is announced that grading has begun on this Washington Territory road, which is orun from Tacoma to American Lake. FREEMAN CAMPBELL, of Tacoma, is interested.

Seattle & Southern.—A press report states that the engineers locating this road have reached a point near Puyallup Junction, on the Northern Pacific. The road is projected to run from Seattle, W. T., to Portland, Ore. M. S. BATES, of Seattle, is Secretary.

Fort Collins, North Park & Salt Lake.—Incorporated in Colorado to build a railway from Denver through Muddy Pass and Buffalo Pass to Salt Lake City, Utah, with branches from Brown's Park, Utah, to Ogden and from Denver to Cheyenne. Among the incorporators are: ISAAC N. VAN DYKE, of Paris, Ill.; HENRY A. CRAFTS, of Fort Collins, Colo., and ABRAHAM LAFEVER, of North Park, Colo.

Rockford & Spokane Falls.—Organized in Washington Territory to build a railway from Rockford, W. T., to Spokane Falls, about 25 miles.

Santa Ana.—Incorporated in California by JAS. MCFADDEN, W. H. SPURGEON, M. M. CROOKSHANK and others of Santa Ana to build a railway 10 miles long from Santa Ana to Newport Beach.

Fresno & Pine Ridge.—This company has been chartered in California with J. P. VINCENT, President; THOS. E. HUGHES, Vice President, and W. H. MCKENZIE Secretary, to build a narrow gauge road 45 miles long. The road is to be completed in 20 months.

RAPID TRANSIT.

Thomson-Houston Electric Railways.—The Thomson-Houston Electric Co., of Boston, Mass., has been obliged to greatly increase its facilities in order to handle its rapidly increasing business in electric railways. In addition to large contracts, closed some time ago, it has lately closed the following:

Lynn, Mass.—Lynn & Boston Ry. Co., Nahant line. This line has 4,300 ft. of track, two turnouts; maximum grade, 4 per cent. It will extend from Central Square, Lynn, to Nahant House, Nahant. One car will be put in operation at first, the power for which will be obtained from the station of the Lynn Electric Light Co.

Newburyport, Mass.—The Newburyport & Amesbury Horse Ry. Co.'s line is about 6 miles in length, and will operate 2 cars. It is made up almost entirely of curves and grades, the maximum of which is 10 per cent. The power will be supplied from the Newburyport Electric Light Co. and the Amesbury Electric Co.

Newton, Mass.—The Newton Circuit Line will operate 10 cars and is 3 miles in length, the maximum grade being 5 per cent. It will run from Newton to Watertown on the West End track, and from Watertown to West Newton and Newtonville on new track.

Plymouth, Mass.—The Plymouth & Kingston Ry. Co.'s line is 4 miles in length, and will operate 3 cars. The maximum grade is 6 per cent. It will run from Chiltonville, through Plymouth to Kingston. On nearly all of the line the bracket method will be used. The track is about laid.

Quincy, Mass.—The Quincy Street Railway Co.'s line will operate 4 cars, and is 5 miles in length. It extends from Quincy through Wollaston Heights and Atlantic to the Neponset river. The bracket method of overhead construction will be used.

The Thomson-Houston Co. has also received orders for new cars from the Wheeling Railway Co., Wheeling, W. Va.; West End Street Railway Co., Boston, Mass.; Topeka Rapid Transit Co., Topeka, Kan.; Omaha & Council Bluffs Railway & Bridge Co., Omaha, Neb., and Lynn & Boston Street Railway Co., Lynn, Mass. It has also constructed a track about 1 mile long for the Hillside Coal Co., at Scranton, Pa., on which a 40 H. P. locomotive is used. This is used for carrying coal, and is capable of hauling about 20 cars loaded with 1 ton each.

Street Railways.—***Des Moines, Ia.***—The Des Moines Street Ry. Co. has transferred four-fifths of its stock to a syndicate headed by Mr. GEO. B. KERPER, President of the Cincinnati Cable Ry. Co.

Centralia, Wash. Ty.—A street railway is projected. Population, 1,500.

Ellensburg, Wash. Ty.—A street railway franchise has been granted to Mr. MOFFIT, of Wichita, Kan., who will build 5 miles this season.

Marysville, Cal.—The Marysville & Yuba City Street Ry. Co. has been incorporated by D. E. KNIGHT, W. T. ELLIS, M. HELLER, and others.

Terrell, Tex.—Application has been made for a franchise for a street railway.

Dummy Lines.—***Salem, Mass.***—The Naumkeag Street Ry. Co. is experimenting with a Prosser steam motor weighing about 8 tons.

Rome, Ga.—The North & South St. Ry. Co. will purhase a dummy engine.

Mobile, Ala.—The City Railway Co. has been granted permission to use steam motors weighing not more than 10 tons.

Anniston, Ala.—The Anniston, Oxford & Oaxanna Street Ry. Co. has made arrangements with the Minneluah Lake Co. to extend the line and use dummy engines.

Warrensburg, Mo.—A company has been organized by M. K. BOWEN, E. P. BATES, and FRANK H. DEXTER, of Kansas City, Mo., to build a dummy line to Pertle Springs. Capital stock, $25,000.

Electric Railways.—***Gloucester, Mass.***—The Gloucester Street Ry. Co. is making arrangements with the electric light company to furnish power for operating the line by electricity.

Providence, R. I.—The Union Ry. Co. has applied for permission to operate its cars by electricity, using the storage battery system.

Lebanon, Pa.—An electric railway is projected. A company will be organized shortly.

Easton, Pa.—New plant, of greater power, has been put in for the electric railway.

West Bay City, Mich.—A company has been organized to build an electric railway.

Denver, Col.—The South Denver Street Ry. Co., which proposes to build an electric road, has received a very favorable report on electric traction from its Secretary, Mr. S. V. FARNUM, who has inspected the Thomson-Houston and Sprague roads at Boston, Mass.

Salt Lake City, Utah.—The City Ry. Co. has awarded to the Sprague Electric Co. the contract for equipping 6½ miles of road. There will be 10 cars, 8 with 15 H. P. motors, and 2 excursion cars of 30 H. P. The rails will be 35 lbs. per yd.

Elevated Railway.—***Chicago, Ill.***—The Union Rapid Transit Co. has been incorporated by WM. R. RAYMOND, DAVID E. SHANAHAN and ELMER E. ROBINSON. Capital stock, $6,000,000. It proposes to build suburban systems of elevated railways.

CONTRACTING.

Cement.—The following proposals for 600 bbls. of 300 lbs. each of natural hydraulic cement for use at the Des Moines rapids canal, were opened April 18 by Major A. MACKENZIE, U. S. Engineer Office, Rock Island, Ill.: Meacham & Wright, Chicago, Ill., $1.16 per bl. in barrels or 95 cts. in bags. Jas. McNamara, Keokuk, Ia., $1.09, 98½ cts.

Stone.—The following proposals for stone for use at the Des Moines rapids canal were opened April 18 by Major A. MACKENZIE, U. S. Engineer Office, Rock Island, Ill.: Patterson Bros., Keokuk, Ia.: $8 per cu. yd. for 295 cu. yds. of face stone, $3 per cu. yd. for 133 cu. yds. of backing stone, $2 per cu. yd. for $2,100 cu. yds. of rip-rap face stone, 65 cts. per cu. yd. for 2,000 cu. yds. of rubble filling, $8,259 total. Fort Madison & Appanoose Stone Co., Fort Madison, Ia.: $8.47 for face stone, $4.90 for backing stone, $1.99 for rip-rap, 78 cts. for rubble; total, $8,889.35.

The following proposals for dimension stone at Lock No. 1, Barren river, and Lock No. 3, Green river, Ky., were opened April 19 by Major D. W. LOCKWOOD, U. S. Engineer Office, Cincinnati, O.: Eizenmann & Hollerbach, Rockport, Ind., $7.65 per cu. yd. for Lock No. 1 (or $6.25 for Green Castle stone); $6.24 per cu. yd. for Lock No. 3; total, 30,019.38. A. R. Stewart, Nashville, Tenn.: $7.29 and $7.92; total, $34,455.42. I. V. Hoag, Jr., Pittsburg, Pa., $10 and $10; total, $44,540. Wm. Willis, Jr., & Co., Rochester, Ky., Lock No. 3 only, $7.70 per cu. yd., $23,270. The contract was awarded to Eizenmann & Hollerbach at $7.95 and $6.24 per cu. yd.

The following proposals for furnishing stone for the construction of a lock in the Wabash river, near Mt. Carmel, Ill., were opened April 23 by Major AMOS STICKNEY, U. S. Engineer Office, Louisville, Ky.: Salem Stone & Lime Co., $15.60 for 116 cu. yds. of special stone, $14.42 for 230 cu. yds. of coping, $13 for 545 cu. yds. of cut stone with dressed face, $12.50 for 535 cu. yds. cut stone with quarry face (or $11.42 if of uneven color), $11 for 400 cu. yds. of backing (or $10.20 if of uneven color). Edward Crumbo, $24 for special, $22 for coping, $18 for dressed face cut stone, $16 for quarry face cut stone, $14 for backing. I. V. Hoag, Jr., $23 for special stone, $17 for coping, $16.50 for dressed face cut stone, $15.25 for quarry face cut stone, $12 for backing.

Street Work.—***Lancaster, Pa.***—The Street Committee has awarded contracts as follows: Laying gutters: T. G. Bach, 2½ cts. per ft. Laying corner-stones: Frederick Wagner, 4½ cts. per ft. Furnishing backing stone: Samuel Resh, 4 cts. per ft., delivered.

Montreal, Que.—The Road Committee has awarded contracts as follows: For paving Craig St. with square tamarac blocks saturated with coal tar: Bastien & Valiquette, $1 per sq. yd. For granite blocks between the tracks: Robert Forsyth, $2 37½ per sq. yd. The contract for laying the whole, including hauling, was given to Bastien & Valiquette. The following contracts were also awarded: Crosswalk flags, N. Y. bluestone, F. D. Lawrence, 75 cts per lin. ft. Stone curbing, gray limestone, straight, 55 cts. per lin. ft.; stone curbing curved, 60 cts. Desormeau & Frere, Portland cement, Johnson's, McNally & Co., 72½ cts. per 100 lbs. Tile pipes, various sizes, Standard Drain Pipe Co. Wrought-iron spikes, 6 x ¼ in. per 100 lbs., $2.82: Peck, Penny & Co. Hardware supplies: M. B. J. Coghlin. Bricks: C. Sheppard, squares 8 x 4 x 2½, $10 per 1,000; invert bevels $12 per 1,000. Castings for gulleys, etc.: P. Amesse, 2 cts. per lb.

Sewer.—***Jamestown, R. I.***—James Corrigan, of Newport, R. I., has the contract for the sewer. The larger part will be built of 12-in. pipe, furnished by Swinburne, Peckham & Co., of Newport. The contract price for the work is 74½ cts. and 99¾ cts. per ft., respectively for 8 and 12-in. pipe when laid, except where the ledge on Walcott Ave. is cut through, and here it is $1.44 per ft., and the 12-in. iron pipe, of which there is to be about 200 ft. laid out into the bay, will cost $1.99.

Dredging.—The following proposals were opened April 23 by Major LIVERMORE, U. S. Engineer Office, Newport, R. I.; the prices are per cu. yd., measured in place.

Hyannis harbor, Mass.: Atlantic Dredging Co., New York, N. Y., 37½ cts.; W. H. Beard, Brooklyn, N. Y., 39 cts.

Wareham harbor, Mass.: Hartford Dredging Co., Hartford, Conn., 55 cts.

New Bedford harbor, Mass.: Hartford Dredging Co., 35 cts.; Atlantic Dredging Co., 36 cts.; W. H. Beard, 40 cts.

Newport harbor, R. I.: W. H. Beard, 41½ cts.; Hartford Dredging Co., 43 cts.; Brainard Bros., New York, N. Y., 43 cts.

Pawtucket river, R. I.: Brainard Bros., 35 cts.; W. H. Beard, 37 cts.

Providence river, R. I.: Atlantic Dredging Co., 19¾ cts. W. H. Beard, 21 cts.

Removing Green Jacket shoal, Providence harbor, R. I.: Atlantic Dredging Co., 16⅞ cts.; W. H. Beard, 17½ cts.

Pawcatuck river, R. I.: E. M. Payn, Albany, N. Y., 38 9-10 cts.; Hartford Dredging Co., 60 cts.

Many of the bids were informal, and no contracts were awarded.

Water-Works Supplies.—The Water Committee, Lancaster, Pa., has awarded contracts as follows for supplies for the year: Lead: Flinn & Breneman, 4¼ cts. per lb. Ferrules: John T. Knapp, 70 cts. each. Special castings: R. Blickenderfer, 2¼ cts. per lb. Stop valves: Eddy Valve Co., of Waterford, N. Y. Hauling pipe, Emanuel Stone, 50 cts. per gross ton. Trenching: Nicholas Nary, 16½ cts. per cu. yd. for earth, and 50 cts. per cu. yd. for rock. Wooden stop-boxes: Wm. Wohlson, 3 cts. per sq. ft. B. M. Iron stop-boxes: Bingham & Taylor, of Buffalo N. Y. Iron pipe: Meliert Foundry & Machine Co., Reading, Pa., $28.57 per gross ton (delivered) for 4-in., $27.78 for 6 and 8 in., $27.55 for 10 and 12-in., $27.33 for 20 and 24-in. Fire hydrants: Eddy Valve Co., of Waterford, N. Y. E. F. FRAILEY is Superintendent of Water-works.

New Croton Aqueduct.—The Aqueduct Commissioners, New York, have awarded to Charles W. Palmer a contract for the iron work of the gatehouse at 135th St. for $6,935, and to Cole, Wilcox & Co., for cast-iron pipe at shaft 24, Section A, for $4,000.

Sewer Pipe.—Seven bids for pipe were received by Mr. DAVID JAMES, Superintendent of Sewer Construction, Salt Lake City, Utah. The highest was from the Globe Sewer Pipe Co., of Pittsburg, and the lowest from their Kansas City Sewer Pipe Co. Their prices were as follows: Globe Co: 24-in., $2.41 per ft.; 20-in., $1.65; 10-in., 42 cts.; 8-in., 30 cts. Kansas City Co.: 24-in., $1.95 per ft.; 20-in., $1.40; 10-in., 34 cts., 8-in., 21½ cts. No weights were given. The bid accepted was that of Blackmer & Post, of St. Louis, Mo., who furnished the following figures:

24-in., 180 lbs.			$2.34½	per ft.
20 "	125 "		1.57½	"
10 "	33 "		35 9-10	"
8 "	23 "		23 9-10	"

To be delivered at Salt Lake City, and the company to take all risks in transit; time of payment, 90 days, or 3 per cent. off. The sockets to this pipe are 4 ins. deep, so that the joints are perfectly tight; and the price is higher per ft. for these sizes than other bids because of the long socket.

Asphalt Paving.—At Kansas City, Kan., it has been decided to lay asphalt paving on Minnesota Ave., at a cost of about $100,000. The Barber Asphalt Paving Co. and the Kansas Paving & Construction Co. have been figuring on the work.

PROPOSALS OPEN.

Water-Works.—About 8 miles of 4 to 10-in. pipe, 60 hydrants, and a pair of pumping engines of 1,500,000 galls. daily capacity. Plans and specifications on file. J. O. BECRAFT, Recorder, Dowagiac, Mich. May 8.

Pier Work.—Repairing crib bulkhead at E. 17th St., North river; 33,083 cu. ft. of crib work; 174 cu. yds. rip-rap. THE DOCKS COMMISSIONERS, Pier A, North river, New York City. May 10.

Road.—About 1½ miles of macadam road in Franklin, Essex Co., N. J. Maps and specifications at the office of Mr. LEONARD RUSBY, at Franklin. ADRIAN VREELAND, Towpship Clerk, Franklin (Nutley P. O.), N. J. May 13.

Dredging.—In harbor at Thunder Bay, Mich. Col. O. M. POE, U. S. Engineer Office, Detroit, Mich. May 14.

Enameled Bricks.—About 550,000 for the Congressional

Library. BERNARD R. GREEN, 145 East Capitol St., Washington, D C. May 16.

Bridges.—Two iron bridges over the Olentangy river, one 190-ft. span; bids for sandstone and iron pile substructures. F. J. REINHARD, County Auditor, Columbus, O. May 16 and 21.

Water Bonds.—Purchase of $45,000 of water bonds. JOHN D. HENDERSON, President Board of Trustees, St. Johns, Mich. May 20.

Building.—Roofing; hollow tile and brick floor; arches and ceiling arches, etc. THE STATE HOUSE COMMISSIONERS, Topeka, Kan. May 20.

Supplies.—Drain pipe, sand and gravel, lime and cement; lumber, bricks, electric light, etc. Capt. JOHN M. WILSON, U. S. A., Office of Public Buildings and Grounds, War Department, Washington, D. C. May 21.

Brush.—About 25,000 cords of willow brush and 4,000 cords of poles. Capt. WM. T. ROSSELL, U. S. Engineer Office, Memphis, Tenn. May 22.

Bridge.—Iron plate girder bridge across the Kenduskeag. P. H. COOMBS, City Engineer, Bangor, Me. May 22.

MANUFACTURING AND TECHNICAL.

The Westinghouse Air Brake is to be fitted to the freight equipment of the Grand Rapids & Indiana road.

Flush Tank.—The Standard Flush Tank Co. has been incorporated at Newark, N. J., by C. P. BASSETT, C. E., A. L. BASSETT, and HORACE H. MITCHELL. Capital stock, $50,000. The apparatus consists of a brick tank with concrete bottom, situated on the head of the sewer it is desired to flush. This trap is connected with the sewer by a running trap. This trap is connected with a siphon which rises up into the brick chamber. On the top of the siphon is a plate containing a rubber valve controlled by a float. The tank is supplied with water from the street main, the water flowing in a small stream. As the water rises in the tank it raises the float, and this opens the valve and allows the compressed air in the siphon to escape, thus putting the siphon into action, and thus the sewage which has flowed into the tank from the buildings along the line of the sewer is siphoned off into the sewer and the return of sewer gas is prevented. The whole process takes about 30 seconds. The apparatus is the invention of Mr. H. H. MITCHELL, and several of these tanks are already in use in Newark and other places. The Government has already ordered several for use in its Western military stations.

Valve Gear.—The Woolf Valve Gear Co., of Minneapolis, Minn., has fitted its improved valve gear to a passenger locomotive on the Omaha road.

Pumping Engine.—The Baltimore United Oil Co. has erected at its oil warehouse, at Canton, a Blake triple expansion condensing pump, with a capacity of 3,500,000 galls. It is for a water supply for condensers at the works of the company, about 4,200 ft. distant. An extra water supply is also afforded in case of fire. The high-pressure cylinder is 8 ins., intermediate 12 ins., low pressure 24 ins. in diameter. The water cylinder is 20 ins. in diameter, and the stroke of piston 24 ins.

The Newark Sand Dredging Co. has been organized by JOSEPH MAYER, of Trenton, N. J., HORACE G. REEDER, I. D. GOBEL, and others, of Bordentown, N. J. Capital stock, $15,000.

Logging Road.—A lumber company has been organized by E. L. TUFTS, M. R. LOWTHER, E. H. RIDDLE, and others, at Parkersburg, Va., to build a tram road from Standing Stone up Standing Stone creek, about 15 or 20 miles, to bring down timber.

Cars.—The Ohio Falls Car Co., of Jeffersonville, Ky., has a contract for 2 combination baggage and mail cars for the Lake Erie & Western.

The Gilbert Car Co., of Troy, N. Y., has delivered 2 passenger cars to the New York Central & Hudson River.

The Pullman Palace Car Co., of Chicago, has an order for one closed passenger car and 6 open tourist cars for the Ilwaco Railway & Navigation Co.

The Smith Safety Steel Railway Car Co. has been organized at Chicago by C. W. SMITH, SAMUEL G. FIELD, and P. A. HOYNE. Capital stock, $1,500,000.

Water Pipe.—The Commonwealth Construction Co., of Philadelphia, Pa., wants about 4 miles of galvanized, wrought or cast-iron pipe.

Railway Material.—The Staunton Improvement Co., Staunton, Va., W. A. BURKE, President, wants rails and cars.

P. L. Corker, of Waynesboro, Ga., wants cars and rails.

The Durham Street Ry. Co., of Durham, N. C., will purchase rails, spikes, and open cars.

J. Baxter Allen, of Anniston, Ala., wants 2 to 3 miles of 25-lb. or 30-lb. steel rails; also second-hand cars with capacity for 14 or 16 passengers.

The Concord Railway Co., Concord, N. C., wants bids for building two miles of railroad, to be laid with 40-lb. steel rails, and bids for 3 cars and one dummy, standard gauge. JOHN P. ALLISON, President.

Cement.—The firm of Dickinson Bros. & King has been organized by John W. and Wm. Dickinson, J. A. King, and I. C. Hutchinson, to take over the business of the Empire Warehouse Co., of Chicago. They are importers of English and German Portland cements. The head office is at 24 State St., New York City, with branch offices at Chicago, Ill., and New Orleans, La.

Locomotives.—The Taunton Locomotive Mfg. Co., of Taunton, Mass., has turned out a six-wheel switching engine for the Old Colony.

The Rhode Island Locomotive Works, of Providence, R. I., have an order for 10 eight-wheel engines for passenger and freight service, for the New York, New Haven & Hartford. Cylinders, 18 x 24 ins. Total weight, 88,000 lbs., with 54,000 lbs. on the drivers.

The Schenectady Locomotive Works, of Schenectady, N. Y., are building a mastodon type engine for the Beach Creek road, and 5 six-wheel switch engines for the Long Island.

Water Motor.—The presses of the *Daily News* of Newburyport, Mass., are driven by a "Little Giant" water motor furnished by the Belknap Water Motor Co., of Portland, Me. The pressure from the street main is from 38 to 42 lbs. and the water is supplied through a 3-in. pipe.

Rails.—The rail department of the Vulcan Iron Works, in Carondelet, Mo., has been overhauled and repaired. There is some prospect that the rail department will soon be in operation again. The only drawback at present is that the price of steel rails does not compensate the company for their manufacture.

Tools.—Mr. MCKIBBON, General Purchasing Agent of the Union Pacific Ry., has awarded the contracts for tools and machinery for the new shops at Cheyenne, Wyo., to Manning Maxwell & Moore of New York; Putnam Machine Works, of Fitchburg, Mass.; and Niles Tool Works, of Hamilton, O. The contracts aggregate about $200,000.

Dump Carts.—The Espey Mfg. Co. has supplied 7 new carts to the Street Cleaning Department, of Portland, Ore., at $70 each.

Bridge Works.—The Louisville Bridge & Iron Co., of Louisville, Ky., will soon rebuild its works, which were recently destroyed by fire.

Water-Works Material.—Pumps, boilers, hydrants, valves and 300 tons of cast-iron pipe for water-works to be built in Maine, are wanted by Jesse W. Starr, of Philadelphia, Pa.

Dredge.—Urie & Son, of Kansas City, Mo., have sold to the City Fuel Co., of Little Rock, Ark., a dredge with a capacity of 8,000 cu. yds. of sand per day.

The Hersey Meter. The following is from the Chicago *Tribune*:

BOSTON, Mass., April 18.—The Hersey Meter Company of Boston have to-day received a telegram from New York that the case of the National Meter Company against the City of Yonkers, as users of the Hersey Machine Company's manufactures, has been decided in the United States District Court in favor of the Hersey Meter Company. As there are 6,000 of these in use in various cities, this decision is of general interest in water departments.

Dredging.—The Columbia National Land Dredging Co. has been incorporated at Washington, D. C., by Jos. K. MCCANNON, R. J. FLEMING, ANDREW M. COYLE and others to furnish cleaned sand and gravel for building purposes. The capital stock is $100,000.

Roads.—The County Commissioners at Huntsville Ala., have appointed MR. CROZIER to prepare plans and specifications for the new turnpikes, for which $100,000 have been appropriated.

The Illinois Steel Co. is to be the new name of the North Chicago Rolling Mill Co., of Chicago, Ill.

The Sampson Steam Forge Co., of Chicago, has been incorporated, capital, $100,000, for the manufacture of locomotive frames and general forgings. Incorporators, S. R. WILSON, F. J. SMITH, J. W. WHITE and F. J. WILSON.

Freight Car Coupler.—Col. HORACE SCOTT, before a number of railway men, recently, made a very satisfactory test of the new King automatic coupler for freight cars, at the Indianapolis (Ind.) car works. The coupler is quite simple, not expensive, and works promptly.

Construction Companies.—The Racine Construction Co., of Racine, Wis., has been incorporated with a capital stock of $15,000.

The Richards-Clegg Construction Co. has been incorporated at Chicago, Ill., by FRANK L. WEAN, WM. W. CASE and JOHN A. BRIGGS, to undertake railway construction. Capital stock, $75,000.

Pumps.—The Colorado Irrigation Pump Co. has nearly completed its works at Greeley, Col.

The Welsbach Incandescent Gas Light Co. has been organized by WM. A. DANA and A. A. DOOLITTLE, of St. Paul, Minn., L. W. WASHBURN, J. F. COLLOM, MILO G. PHILLIPS, of Minneapolis, and others. Capital stock, $500,000.

Pumps.—The Kensington Engine Works, Ld., of Philadelphia, have issued an illustrated catalogue of the Dow positive piston pump, in which the rotary piston moves the water continuously forward.

BRIDGES AND CANALS.

Bridges in Colorado.—The Governor of Colorado has signed bills authorizing the construction of a bridge over Grand river at Glenwood Springs; over the Gunnison river in Montrose Co.; over the Bear river in Routt Co.; over the Grand river in Eagle Co., and over the Gunnison river in Delta Co.

Drawbridge.—Shafler & Schniglau, of Chicago, have been awarded the contract for a railway bridge in Canada, consisting of one draw span of 200 ft. and 2 fixed spans of 90 ft. each.

Bridge Notes.—***Bangor, Me.***—Proposals for a plate girder bridge over the Kenduskeag river will be opened May 22 by P. H. COOMBS, City Engineer.

Concord, Mass.—The town has voted to build a new pile bridge at Nine Acre corner at a cost of $2,000.

Holyoke, Mass.—The Committee on Highways and Bridges has been given charge of the question of bridging the second level canal at Dwight and Cabot Sts.

Buffalo, N. Y.—The following proposals for bridges over the Buffalo river have been received by City Engineer GEO. F. MANN: Abbot's Corners bridge: King Iron Bridge & Mfg. Co., Cleveland, O., $13,975, with $200 allowance for old bridge; A. D. McConnell, $14,800, with $200 allowance; Berlin Iron Bridge Co., East Berlin, Conn., $15,200, with $300 allowance; H. Clark and Pittsburg Bridge Co. sent informal bids. Seneca St. bridge: H. Clark, $6,850; King Iron Bridge & Mfg. Co., $10,375; A. D. McConnell, $9,900; Berlin Iron Bridge Co., $9,980; Pittsburg Bridge Co., informal.

Stockport, O.—The contract for a bridge over the Muskingum has been let to Branham & Hegue, of Indianapolis.

New Albany, Ind.—The contract for an iron bridge across Falling run, at West 7th St., has been awarded to the Columbus Bridge Co.

Kansas City, Kan.—The Kansas City Bridge & Iron Co. has contracts for the County Commissioners.

New Westminster, Wash. Ty.—The Central Pacific proposes to put an 80-ft. draw in the St. Mary's bridge, but the Board of Trade wants a span of 100 ft.

Bear Lake, Idaho.—The Bear River suspension bridge has been accepted by the County Commissioners.

Watsonville, Cal.—The Monterey County Supervisors have decided to build a wooden or iron bridge across the Salsipuedes Creek, near Watsonville, in place of the present old bridge.

ELECTRICAL.

Electric Lighting.—***West Troy, N. Y.***—The village clerk has been directed to advertise for bids for lighting.

Tiffin, O.—The new electric light plant was put in operation April 20.

Belleville, Ill.—The Belleville Electric Light & Power Co. has been incorporated by EDWARD ABEND, JOHN EIMER, A. KARR and others. Capital stock, $25,000.

Bloomington, Ill.—An electric light company with $15,000 capital stock is to be organized by JAMES WILCOX, GEO. W. FUNK and T. F. HARWOOD.

Milwaukee, Wis.—The Milwaukee Electric Light Co. has been organized at Chicago by JOHN WALSH, F. B. UHRIG and M. B. AUSTIN. Capital stock, $100,000.

Fargo, Dak.—The Fargo Gas & Electric Co. has contracted for lots adjoining the gas works, and will erect a brick building for the incandescent light plant. It will consolidate the electric and gas plant, increase the power, and, as soon as possible, extend the lights through the residence portions of this city and Moorhead. The new machinery has been contracted for, and the new building is to be completed by May 15.

Kirkwood, Mo.—After considering propositions for electric lighting, the town postponed further consideration, as the town finances do not warrant the necessary expenditure.

Livingston, Mont.—The Thomson-Houston Co. has a contract for a plant of 20 arc lights and 600 incandescent lights. E. E. STEBBINS is a member of the local company.

Montreal, Que.—The location of the electric lights has been settled. There will be 750 arc lights and 250 incandescent lights.

The Thomson-Houston Electric Co., of Boston, Mass., reports a number of orders for arc and incandescent lamps and for stationary motors.

WATER AND MUNICIPAL.

Binghamton, N. Y.—The Water Commissioners have issued their report for 1888. During the year the pipe extensions were 9,808 ft. of iron pipe; 24,066 ft. of iron pipe were put in to replace the old cement pipe, which is now entirely removed, and the city has now about 31 miles of cast-iron mains. The total pumpage was 1,055,574,046 galls., an increase of 137,603,190 galls. over 1887, which increase was largely due to the severe weather of the first part of the year. There are 336 valves, 291 hydrants, and 233 meters. D. FELTER is Superintendent.

Jacksonville, Fla.—The Trustees of the Sanitary Improvement Board have issued their report for the year ending July 1, 1888. Some decrease in the flow of the artesian wells was found in the winter and spring, but in June the flow increased again. The total amount pumped was 409,809,474 galls.; about 200,000 galls. per day were used for flushing sewers, watering streets, fountains, etc. There are 385 meters. Mr. ELLIS, the Engineer and Superintendent, repeats his recommendations

that a stand-pipe be erected. The publication of the report at the usual time was prevented by the epidemic last summer, and was still further delayed by the death of Col. J. J. DANIELS, the Secretary.

Toledo, O.—The Trustees of the Water-Works have issued their report for 1888. Subsiding reservoirs are again recommended, to be supplied from above Providence dam. About 7 miles of pipe were laid. The total consumption was 1,747,587,756 galls. There are 62.9 miles of pipe, 349 meters, 529 valves and 435 hydrants. H. C. COTTER is Superintendent.

Fairbury, Neb.—The works were commenced Nov. 1, 1888, and completed Feb. 1, 1889. C. F. MCLAIN was the Constructing Engineer, and A. L. Strang, of Omaha, was the contractor; Shickle, Harrison & Howard supplied the pipe; Chapman valves are used. The supply is taken from wells and pumped to a stand-pipe 12 x 100 ft.; for fire purposes a supply is drawn from the Blue river. There are 2 duplex Knowles pumps, one high-pressure and one compound, both of 1,000,000 galls. daily capacity; 30,000 ft. of 4 to 12-in. cast-iron pipe and 63 hydrants. Population, 4,000. The works are owned by the Fairbury Water-Works Co.; President, F. L. BUCK; Secretary, C. F. MCLAIN; capital stock, $75,000; bonds, $50,000. The franchise is for 25 years and the hydrant rental is $3,000 per annum.

Bounty for Artesian Wells in Nevada.—The artesian well bill passed by the Nevada Legislature provides that every person or company that shall, after the passage of the Act, commence the sinking of artesian wells shall be entitled for sinking such well, where flowing water is obtained, the following specific sums: For the first 200 ft., $1.25 per ft.; for the third 100 ft., $1.50 per ft.; for the fourth 100 ft., $2 per ft.; for the fifth 100 ft., $2.20 per ft.; for the sixth 100 ft., $2.50 per ft.; for the seventh 100 ft., $3 per ft.; for the eighth 100 ft., $3.50 per ft.; for the ninth 100 ft., $4 per ft.; for the tenth 100 ft., $4.50 per ft.; for all depths exceeding 1,000 ft., $5 for each foot below 1,000 ft., and an additional bounty of $1,000 for every well sunk to the depth of 1,000 ft. or more, said well to furnish a flow of 20,000 galls. of water every 24 hours for 30 days successively. No bounty shall be paid on any well which does not furnish 7,000 galls. of water in 24 hours, flowing continuously for 30 days; and no two wells should receive a bounty if located in the same country.

Water-Works in Pennsylvania.—Messrs. S. H. LOGAN, W. F. WALLACE, O. R. COOK, W. P. LOGAN, and R. F. HUNTER, C. E., are the temporary directors of a corporation composed of substantial men of Pittsburg and vicinity, who are about to erect a number of water-works. The syndicate has applied for charters and proposes erecting works at Mansfield and Chartiers boroughs and in Mifflin township. The Mifflin township reservoirs will be erected on the heights across the Monongahela from McKeesport and some distance back in the country. By the peculiar curve in the Monongahela river these reservoirs will be equally accessible to Homestead, Duquesne, Stonesburg, Dravosburg, Camden, and even Coal Valley.

Jamestown, N. Y.—The Jamestown Water Supply Co. has been bought out by the American Water-Works & Guarantee Co., of Pittsburg, Pa., and the following are the officers of the reorganized company: President, W. S. KUHN; Secretary, J. A. MORROW; Treasurer, S. M. HIGHLANDS. The pumping capacity will be increased, new boilers put in, and the pipe system extended.

Gas Works.—***Brunswick, Me.***—Mr. B. L. DENNISON has leased the Brunswick Gas Works to the Union Gas & Fuel Co. now located at Bath. A new system of gas making will be introduced, probably at a lower price. The works are leased for 25 years.

Amherstburg, Ont.—The Council have given the Walker Gas Co. the right to pipe the town, providing the pipes are put down before April 1, 1891, or within months of their being laid in Windsor.

St. Louis, Mo.—A syndicate of New York and Philadelphia capitalists has purchased the Laclede gas works for $3,500,000, and the St. Louis gas works for $5,500,000. The two companies will be consolidated.

Water Gas.—At Akron, O., a company has been organized to manufacture water gas, which it is proposed to furnish at 40 cts. per 1,000 cu. ft.

Sewerage.—***Jamestown, R. I.***—Work on the sewer has been commenced. James Corrigan, of Newport, is the contractor, and the pipe is supplied by Swinburne, Peckham & Co., of Newport.

Canton, N. Y.—An appropriation of $35,000 for sewers has been made.

Kingston, Pa.—The borough engineer has presented plans for a sewerage system to cost $22,000.

Tuscaloosa, Ala.—Propositions for putting in sewerage system are being received by the mayor.

Ann Arbor, Mich.—A council committee has been appointed to obtain estimates on the cost of a sewerage system. J. E. BEAL and H. T. MORTON are on the committee.

Little Rock, Ark.—A sewer district is being organized for the purpose of putting in additional sewers in the south part of the city. Mr. F. J. H. RICKON is City Engineer.

Helena, Mont.—The City Council has decided to push work on the sewerage system this year and will issue $130,000 in bonds during May.

Salt Lake City, Utah.—The mayor has awarded a $20,000 contract for 20 and 24-in. sewer pipe to Blackmer & Post, of St. Louis, Mo.

Seattle, Wash. Ty.—Since the city declined the proposition made by Col. WARING, several other propositions have been received by the City Clerk, including one from Mr. C. F. LOWETH, M. Am. Soc. C. E., of St. Paul, Minn.

Pasadena, Cal.—The sewer bonds have all been disposed of. Trouble is anticipated concerning the matter of the disposal of the sewage on the farm purchased for the purpose, 4 miles south of the city, and an attempt will be made to dispose of the city sewage by the West system.

Brockville, Ont.—Proposals for $100,000 debentures to be issued for sewerage purposes will be received until May 25 by G. T. FULFORD, Chairman of the Finance Committee.

Newark, N. Y.—The new 5,000,000-gall. pump for the high service system has been completed and put in position in the Clifton Ave. pump-house, and the connections with the street mains made. The pump is what is known as a Worthington duplex compound pump. It will be used for either the high service or extra high service system, as occasion demands. It will have connections with the 24-in. main in Clifton Ave. for the high service system, and with the 20-in. main for the extra high service system. The new pump cost $17,000. The 10-in. connections with the 10, 20 and 24-in. street mains were made by means of the patent tapping apparatus invented by Supt. ANTHONY P. SMITH, without shutting off the water. The connections between the pump and the distributing mains are so arranged that, in case of an accident to either level, that level can be supplied with water from the other levels through any of the other pumps. The Aqueduct Board has now seven pumps in use. Four of these are at the Belleville pumping station on the river bank and three at the high service pumping station at Clifton Ave. Two of the pumps at Belleville are 5,000,000-gall. pumps and two are 8,000,000-gall. pumps. These raise all the water from the river that is needed to supply the entire city, and force it through large mains up to the receiving reservoir on the hill about a mile away. From thence it flows by gravity to the city, where it is distributed through the various service mains, either by pumping or gravity. The city water supply is divided into four levels, the Belleville level, the low service, the high service, and the extra high service levels.

Denver, Col.—A new water company is to be organized to furnish a water supply from artesian wells; Mr. J. W. STRAYER is at the head of the project. The new company, recently organized by members of the original company, however, claims that its system will be very extensive and will cover the ground proposed by the projected company. One of the projects of the new Citizens' Water Co. is to tunnel the range and bring an ample supply of water from the Grand river. Surveys for this tunnel are said to be in progress.

Artesian Wells.—***Louisville, Ky.***—A well, lined with galvanized iron pipe, is to be sunk on Jefferson St. Address Hon. CHAS. D. JACOB, Mayor.

Charleston, N. C.—The new 6-in. well in the suburbs has reached a depth of 1,900 ft. and flows over 600 galls. per min.; the well is to be 2,000 ft. deep. Col. DAVIS is Secretary of the water company. The two wells in use yield 500,000 galls. per day.

Greenville, Ill.—The Expert Milling Co. will put down an artesian well.

Portland, Ore.—Several private wells are to be put down. Mr. Corbett has the contract for some of them.

Walla Walla, Wash. Ty.—Watson Bros., well borers from Ritzville, will put down an artesian well on Eureka flat for the Oregon & Washington Territory Ry. Co. They also have in contemplation a number of artesian wells on the flats for private parties.

Oakland, Cal.—The Piedmont Cable Ry. Co. has struck water in its new wells at Lake Merritt.

Trinidad, Col.—A proposition to put down artesian wells has been made by parties from Denver and is favorably considered.

Weatherford, Tex.—The water-works company is putting down an artesian well.

San Antonio, Tex.—The Crystal Ice Co. has struck water at a depth of 700 ft. and will put down another well at once. The flow is about 1,500,000 galls. per day.

Houston, Tex.—The well at Magnolia Park is 158 ft. deep and flows 500,000 galls. per day. George Rauss was the contractor. A well is being put down at the electric light works and another at the water-works. There are now 15 wells in the city.

Water Works.—***Connecticut.***—Portland. The town has voted to have water pipes laid and 70 hydrants put in. Messrs. Wheeler & Parks, of Boston, have set engineers at work surveying the lines. This firm will immediately lay about 5 miles of pipe.

New York.—Gloversville. The survey for the pipe line for the new water-works is completed.——Lansingburg. The Water Commissioners have been authorized to issue $10,000 in bonds to repair the dam at the lower reservoir.—— Westfield. Bids for water-works will be opened by the Water Commissioners May 11. There will be 45,000 ft. of 4 to 14-in. iron pipe and 16,000 ft. of 12-in vitrified pipe; hydrants, filters, reservoirs, etc.——Schenectady. A pumping engine of 5,000,000 or 6,000,000 galls. daily capacity is to be put in.——Far Rockaway. The water-works of Far Rockaway are engaged in laying mains from the wells about to be driven on their property north of the railroad track to the engine-house. It is thought it will tax the works severely the coming season to supply Far Rockaway and Rockaway Beach with water. Five new wells are being sunk on the five acres of property lately purchased of J. B. Remsen, which will considerably increase the supply.

New Jersey.—Camden. It is said that the extension of the Fisher's Point dike by the Government will seriously affect the water supply.——Collingwood. The village may be supplied with water by a pipe line from the works at Haddonfield, 3 miles distant.

Pennsylvania.—McKeesport. Crabs recently caused a leak in the reservoir.——Homestead. The Homestead Water Co. has been organized by ARTHUR KENNEDY, CHAS. W. ROBINSON, and HENRY SPOONE.——Wilkinsburg. James H. Harlow & Co., of Pittsburg, are building works to supply the suburban territory between Pittsburg and Braddock.

Maryland.—Centreville. The council met April 29 to issue $15,000 bonds for water-works. No plan has yet been adopted or contract made. The stand-pipe system will probably be adopted. If more money is required, the council has authority to issue more bonds. For particulars address Mr. W. F. HARMAN.

Virginia.—Wytheville. The water supply will be taken from springs.

Georgia.—Cartersville. The Jeter & Boardman Gas & Water Association are busy constructing Cartersville's water-works. It is their purpose to put water on the town within the next three months. The mains have already been placed on the principal streets, and the masons are rapidly building the pumping station.

Ohio.—Lancaster. The new Board of Water-Works trustees has elected JACOB ORMAN, President; and LOUIS SNYDER, Secretary.—— Fostoria. The city proposes to build its own works.——Washington. The city council has granted the water company an extension of 90 days from April 23 for the completion of the works.

Indiana.—Arcola. Water-works are wanted, but no definite steps have yet been taken for their construction.

Michigan.—Port Huron. The city water-works are said to have brought the city $12,000 last year.——Marshall. Moffett, Hodgkins & Clarke, of Watertown, N. Y., have started work on their contract; there are to be 10 miles of pipe laid.——St. Ignace. A vote on the issue of $40,000 in water bonds was taken April 2 and carried by 437 majority. The council will probably have works put in as soon as possible.——Northville. It is said that water-works will not be built this year.——Grand Rapids. The $80,000 water-works bonds were sold April 24 to N. J. Hayes & Son, of Cleveland, for $94,987; they are 5 per cent. 20 year bonds.——Dowagiac. Proposals will be received until May 8 by J. O. BECRAFT, Recorder, for building water-works; about 8 miles of 4 to 10-in pipe, 60 hydrants and 2 pumping engines of 1,500,000 galls. daily capacity.——St. John's. Proposals for $45,000 water bonds, to provide money for building water-works, will be received until May 20 by JOHN D. HENDERSON, Village President.

Iowa.—Cherokee. The water-committee will open bids for water-works on May 15. There will be a pumping engine of 1,000,000 galls. daily capacity; boiler; stand-pipe 18 x 80 ft.; 250 tons of pipe and specials; hydrants, valves, etc. W. W. CURTIS, of St. Paul, is the engineer.

Montana.—Missoula. The Missoula Water Power & Irrigation Co. has been organized by FRANK LONGSTAFF, GEO. F. BROOKS, and JOHN CORNISH, to furnish the city with water, and also to supply water for irrigation and power. Capital stock, $500,000.

Texas.—Waco. J. D. BELL, who recently arranged to build water works, has contracted to supply the city with water for fire purposes for 15 years.——Llano. The Llano Water Supply Co. has been organized by J. H., M. S., and W. KNOWLES. Capital stock, $25,000.

Colorado.—Central City. A special election was held April 17 at which the proposition to fund the city indebtedness incurred in the purchase and construction of water-works, by issuing bonds to the amount of $30,000, was submitted to the qualified voters. The proposition was carried.

Washington Territory.—Montesano. Water-works are to be built.——Cheney. The city has ordered a special vote on the water-works question.

Utah.—Springville. The city council has employed M. F. STURGIS, C. E., of Salt Lake City, to examine the reservoir sites. The one which he will probably recommend will give a capacity of 100,000,000 galls. The dam will be 300 ft. wide and 40 ft. deep. The water will be taken from springs on the reservoir site and from a mountain stream, and will be held at an elevation of about 100 ft. above the city.——Nephi. The plans for water-works have been completed, and works will be started as soon as the financial arrangements are made. There will be 680 ft. of 10-in. pipe, 6,449 ft. of 8-in., 1,056 ft. of

6-in., 8,806 ft. of 4-in., and 1,128 ft. of 3-in.; 20 gates, 12 hydrants. Reservoirs of 300,000 galls. capacity, built of redwood. Gravity system, 160 ft. head. The water is obtained from springs 4 miles distant. The plans have been prepared by M. F. STURGIS, C. E., of Salt Lake City. Population of town, 3,000.

Canada.—Windsor, Ont. The Water Commissioners have awarded the contract for the water-works building to H. Reaume & Son, at $5,600.——Lachine, Que. The contractors for the new water-works failed to complete the laying of the main across the canal before the water was let in. Temporary arrangements have been made, but this part of the work cannot be resumed before next spring.

Special Reports of Water-Works Construction.

Dartmouth, N. S.—The following was given by E. H. KEATING, Halifax, N. S.:

Dartmouth has an estimated population of 4,000, and now takes its water supply from wells and a stream back of the town. A gravity supply will probably be introduced from Lamont's and Topsail lakes, three miles distant, and 224 ft. above tide. The town has issued debentures to pay for the works, the estimated cost being $60,000. There will be about one-half mile of 18-in. supply main, and 2½ of 12-in. The distributing mains will be 10 to 6-in. pipe. E. H. KEATING is engineer. Contracts will be let May 1, and it is hoped that the works will be completed in the fall.

Manchester, Conn.—The following details are given by E. H. PHIPPS, New Haven, Conn.:

The Manchester Water Co. let contracts April 1 to the Connecticut Patent Water Pipe Co., of New Haven, who began construction April 20, and hope to finish July 1. WM. TOULDS is president of the company, and E. H. PHIPPS is engineer. A reservoir will be built on White's brook from which water will be pumped directly to the mains. Estimated cost, $45,000. Population, 3,000.

Morgantown, W. Va.—E. M. GRANT has sent the following:

The Union Improvemet Co., with J. M. ROWLAND, Emlenton, Pa., as president, will build a *gravity* system of water-works between now and July. The supply will be from springs on Laurel Ridge, and there will be a reservoir or tank on the pipe line. Estimated cost, $30,000. Prof. T. M. JACKSON, of the University of W. Va., is engineer. Population 1,500.

Cordele, Ga.—The information given below was furnished by J. E. D. SHIPP, Cordele, Ga.:

An artesian well is being sunk, and water-works costing $10,000 will be put in by the town. Population, 3,000.

Russellville, Ky.—The following facts were given by T. W. LIVEBOUGH:

Several companies have made estimates for works, but no plan has been adopted by the town. The town will either vote bonds or grant a franchise to a company. Water would be pumped from a spring, probably to a stand-pipe. Estimated cost, $30,000 to $40,000. M. B. BOWDEN is Mayor.

Seymour, Ind.—Regarding water-works here, W. E. MCMILLAN, of Paris, Ill., sends the following:

The Seymour Water Co. is now building works at an estimated cost of $80,000. S. H. LOCKETT, New York City, is engineer, and W. E. MCMILLAN, Paris, Ill., contractor. Water will be pumped from White river to a stand-pipe. There will be 100 hydrants, for which the town pays $4,500 a year. The contracts are all let, Dennis, Long & Co., Louisville, Ky., furnishing the pipe, and the Smith-Vaile Co., pumps with a daily capacity of 3,000,000 galls. Population, 7,000.

Dowagiac, Mich.—The Recorder, J. O. BECRAFT, has sent us the following:

The population of the town is about 3,500. Bonds will be issued to build works costing $40,000. The supply will be from wells. Plans and specifications can now be seen at the Recorder's office, and contracts will be let May 8.

Sturgis, Mich.—The following details were given by M. E. AULSBROOK, Village President:

The town will bond itself to build water-works costing about $30,000. The supply will be from wells. Contracts will be let about May 20. Population, 3,000.

Camp Sheridan, (Highland Park P. O.), *Ill.*—The following details are from Capt. CROSBY P. MILLER, U. S. A.:

The Government will build works costing $102,000, pumping water fro n Lake Michigan to a 100,000-gall. reservoir. The works will supply 600 men at first, and later probably 1,200. Proposals were opened April 22, but the results were not known at time of report.

Ripon, Wis.—The following details are from C. B. DICKINSON, City Clerk:

The Ripon Water-Works Co. has contracted with the village to complete works by Dec. 31. The supply will probably be from wells, by pumping to a stand-pipe. There will be 5¼ miles of pipe and 70 hydrants. Population, 4,000. Address T. D. STONE, Ripon, for all further information.

Madison, Neb.—We have received the following information from GEO. A. LATIMER, Norfolk, Neb., who is engineer for the works at Madison:

The village has a population of 1,000 and is building works to cost about $14,000. The supply will be from driven wells 100 ft. deep, by pumping to stand-pipe. Contracts were let April 1 and the works are to be finished July 1. G. E. FENTON made the surveys. FRANK PRINCE is Mayor.

Marceline, Mo.—J. HEMMING informs us that the works here will be begun May 1, and finished July 1, by E. E. STEVENS & Co., Beloit, Kan., who should be addressed for further details. Population, 3,000.

Holyoke, Col.—A correspondent sends the following: The population is 700. Water will be pumped from wells to a tank at an estimated cost of $10,000. The works will be owned by the Lincoln (Neb.) Land Co., of which R. O. PHILLIPS, Lincoln, Neb., is Secretary. Contracts will be let about June 1.

Nephi, Utah.—We have received the following information from M. F. STURGIS, Salt Lake City, who is engineer for the works:

A private company will build works in the city's interest at a probable cost of $25,000, which will be met by bonds bearing 7 per cent. interest. Proposals for the bonds will be asked in June. It is expected that contracts will be let and work begun about July 1, and that the works will be finished Nov. 1. At present the only supply is from Salt Creek, the water of which is unfit for use. The new supply will be from four miles distant, in a canyon, from which it will flow to a reservoir. ALMA HAGUE is Mayor, and J. HICKMAN, Recorder of the village, which has a population of 3,000.

sions and Additions to Water-Works Systems Contemplated for '89.

(*Continued from page 388.*)

City or Town.	Pipe.	Hydrants.	Valves.	Meters.	Address.
Concord, N. H.	500 ft. 6-in.—1,500 ft. ft.4-in	4	8	.....	V. C. Hastings, Supt.
Great Falls, "	10,560 ft. 10, 8, and 6-in	12	12	.....	H. C. Chase, "
Manchester, "	7,920 ft. mostly 6-in	6 or 8	6 or 8	.....	A. E. Stearns, Reg.
Brattleboro, Vt.	15,840 ft. 8 and 6-in.	9	10 or 12	(?)	G. E. Crowell, Owner.
Vergennes, "	800 ft. 4-in	1	1	.....	S. D. Miner, Com'r.
Boston, (E. Div.) Mass	115,600 ft	100	200	.....	Chairman Water Board
Cambridge, "	3,960 ft. 12-in.—5,280 ft. 6-in.—3,960 ft. 4-in	25	40	"Few"	H. Nevons, Supt.
Medford, "	7,000 ft. 8 in.—1,000 ft. 6-in.—1,000 ft.4-in.	9 to12	12	.....	R. M. Gow, "
Middleborough, "	1,000 ft. 6-in.—1,000 ft. 4-in.—2,800 ft. 12-in.—2,200 ft. 20 in	2	4	6	J. E. Beals, "
New Bedford, "	1,000 ft. 10-in.—4,000 ft. 8-in.—5,000 ft. 6-in.—2,000 ft. 4-in	40	50	12	R. C. P. Coggeshall, Supt.
Newton, "	21,120 ft	40	25	150	H. N. Hyde, Jr. "
Woburn, "	1,500 ft. 6 and 4-in	4	2	.....	A. P. Barrett, Clerk
Worcester, "	2,640 ft. 12-in.—5,280 ft. 8-in	60	75	575	J. G. Brady, Supt.
Phenix, R. I.		.....	.....	6	A. F. Hill, "
Pawtucket, "	15,840 ft. 6-in.—2,640 ft. 4-in	25	40	150	E. Darling, "
Westerly, "	10,560 ft. mostly 6-in	.....	.....	30	E. Barnes, "
Woonsocket, "	*9,000 ft. 6-in.—1,000 ft. 4-in	35 to 40	15 to 20	75 to 100	B. I. Cook, "
Ithaca, N. Y	3,000 ft. 8-in.	5	20	.....	E. M. Treman, Secy.
Saratoga Springs, "		10	20	.....	S. F. Carey, Clk.
Sing Sing, "	6 . 6 and 4-in.	5	11	.....	J. W. Kittrell.
Waterford, "	† 600 ft. 6-in., 400 ft. 4-in.	4	5	25	W. A. Dennis, Supt.
Watertown, "	18,480 ft. 8, 6 and 4-in.	30	30	3 or 4	J. C. Knowlton, Prest.
Waverly, "	3,000 ft. 4-in.	.....	2	.....	J. T. Sawyer, "
Yonkers, "	5,280 ft. 8 and 6-in.	15	6	100	S. A. Lockwood, Supt.
Burlington, N. J.	5,280 ft. 6-in.	5	4	.....	G. A. Allinson, "
Merchantville, "	‡ 1,840 ft. 4-in.	5	5	.....	A. G. Catteli, Prest.
Phillipsburg, "	2,640 ft. 6 and 4-in.	3	4	.....	G. G. Stryker, Supt.
Altoona, Pa.		12 or 15	.....	.....	S. A. Galley, "
Bradford, "	14,000 ft. 6, 4 and 3-in.	22	71	.....	C. J. Lane, "
Chambersburgh, "	** 300 ft. 6-in.	4	3-36 in.	.....	A. C. McGrath, "
Johnstown, "	21,120 ft. 36-in. "Contracted for."	.....	1-20 in.	.....	Jas. Williams, "
Minersville, "		.....	.....	2	C. R. Kear, Secy.
Philadelphia, "	280,000 ft. 48, 36, 30, 20, 12, 10, 8 and 6-in.	300	550	Few.	J. L. Ogden, Chf. Engr.
So. Easton, "	600 ft. 6 in.	13	13	.....	W. B. Solliday, Secy.
Tremont, "	¶ 2,000 ft. 6 and 4-in.	.....	.....	.....	I. P. Bechtel, Supt.
Wilkes Barre, "	31,680 ft. 24, 14 and 4-in.	10	40	4	R. McGarry, "
Williamsport, "	10,000 ft. 12, 8, 6 and 4-in.	"To decide."	12	"Don't we can."	W. H. Bloom, Secy.
Dover, Del.	1,350 ft. 4 and 2-in.	2	.....	.....	T. F. Cook, Chf. Engr.
Frederick, Md.	8,000 ft. 10, 8 and 4-in.	"Can not say."			J. F. Eisenhauer, Prest.
Liberty, Va.	2,000 ft. 4-in.	3 or 4	.....	.....	W. F. Fitzpatrick, Supt.
Norfolk, "	12,000 ft. 12, 6 and 4-in	15	30 or 40	A few.	J. R. Todd, Reg.
Portsmouth, "	2,000 ft. 6-in.	2	4	3	G. H. Coleman, Supt.
Wheeling, W. Va	4	.....	.....	"Don't know"	J. Cummins, "
Charleston, S. C.	10,560 ft. 8-in.—21,120 ft. 6-in	120	50	.....	Z. Davis, Secty.
Savannah, Ga		25	.....	.....	A. N. Miller, Supt.
Orlando, Fla.	30,624 ft. 10, 8, 6 and 4-in	15	54	3	Orlando Water Co.
Baton Rouge, La.	300 ft. 8-in.	.....	2	.....	L. P. Amies, Supt.
Knoxville, Tenn.	3,500 ft. 8 and 4-in. " or more"	4 or more.	7 or 8	"Cannot say."	A. H. Martine, "
So. Pittsburg, "	4,000 ft. 8 and 6-in	Unknown.			F. P. Clute, "
Bowling Green, Ky.	5,280 ft. 8-in. " on hand"	10	6	Unk'n.	J. H. Wilkinson, "
Henderson, "	10,560 ft. 6, 4 and 3-in	6	6	3	J. P. Wigal, "
Lexington, "	2,100 ft. 6 in.	7	7	200	S. A. Charles, "
Louisville, "	42,240 ft. 20 to 4-in	.....	165	250	Chas. Hermany, Chf. Engr
Newport, "	1,000 ft. 4-in	12	12	.....	B. R. Morton, Supt.
Dayton, O.	5,280 ft	10	12	.....	C. A. Herbig, Secy.
Fremont, "		.....	.....	3 or 4	C. F. Reiff, Supt.
Mt. Vernon, "	3,000 ft. 4 in.	4	3	.....	C. W. Koons, "
Salem, "		.....	.....	25	F. W. Allison, "
Zanesville, "	10,560 ft. 6 and 4-in	"Home made." 12	16	.....	R. M. Saup, Supt.
Ft. Wayne, Ind		.....	.....	Few.	P. J. McDonald.
Indianapolis, "	15,000 ft. 24, 16 and 12-in. " Contracted "	25	15	30	F. A. W. Davis, Supt.
La Fayette, "	7,000 ft. 10, 6 and 4-in	12	16	20	J. Barnet, "
Logansport, "	†† 600 ft. 6 and 4-in.	2	.....	.....	W. A. Osmer.
Battle Creek, Mich	10,560 ft. 6-in	10 to 20	12 to 18	10 or more	W. W. Brigden, Supt.
Bay City, "	10,560 ft 6-in. " Wyckoff "	15	20	20	E. L. Dunbar, "
Grand Rapids, "	To lay some cast-iron pipe	.....	.....	.....	F. A. Twamley, Secy.
Lansing, "	†† 2,700 ft. 10 and 6-in	5	2	12	W. S. Wright, Supt.
Manistee, "	15,840 ft. 6 and 4-in	6	3 or 4	.....	G. A. Hart, Secy.
Jacksonville, Ill.	5,280 ft. 6-in	8	8 or 10	10	D. C. Fry, Supt.
Lake View, "	15,780 ft. 8, 6 and 4-in	16	38	.....	H. C. Leach, City Engr.
Quincy, "	5,280 ft. 6-in	10	8	50	W. B. Bull, Supt.
Rockford, "	10,560 ft., 6, 4 and 2-in	6	12	.....	J. T. Lakin, "
Sycamore, "	3,960 ft. 4-in	10 or 12	3 or 4	.....	J. B. Whalen, "
Waukegan, "	2,640 ft. 8-in	6 or 8	.....	.....	A. B. Palmer, Clerk.
LaCrosse, Wis.	4,089 ft. 6-in	7	5	.....	T. S. Vicker, Supt.
Milwaukee, "	79,200 ft. 24 to 6-in	140	120	1,000 to 1,500	G. M. Benzenberg, City Engr.
Cedar Falls, Ia.	2,640 ft. 4-in.	.....	.....	.....	C. Bockniler, Supt.
Davenport, "	21,120 ft. 12, 8 and 6-in.	40	50	.....	J. P. Donahue, "
Austin, Minn.		10	15	25 to 30	J. M. Greenman, "
Atchison, Kan.		19	6	15	E. S. Wells, "
Leavenworth, Kan.	6,800 ft. 8 and 6-in.	11	16	.....	S. Hastings, "
Peab. dy, "	63,360 ft. 8 and 6-in	8 or 10	3	.....	W. K. Palmer, "
Pittsburgh, "	8,000 ft. 4-in	15 or 20	.....	.....	J. M. Goff, Secy.
Topeka, "	10,560 ft. 18 to 6-in.	15	10	10	M. O'Brien, "
Lincoln, Neb.	5,280 ft. 6-in.	17	5	Unk'n	J. L. Lyman, Supt.
Sioux Falls, Dak	7,920 ft. 6-in.	9	3	.....	R. W. Barnes, "
Yankton, "	13,200 ft. 8, 6 and 4-in.	14	17	.....	L. Karr, "
Cheyenne, Wy. T.	21,120 ft. 30 to 4-in.	.....	.....	.....	D. Miller, "
Billings, M. T.	3,000 ft. 4-in.	4	4	.....	H. W. Rowley, "
Carthage, Mo	5,280 ft. 4-in.	3 to 5	.....	5	H. H. Harding, Secty.
Hannibal, "	2,500 ft. 6-in.	2	.....	Unk'n	C. I. Lewis, Supt.
Kansas City, "	105,600 ft. 12, 10 and 6-in.	150	100	500	B. F. Jones, "
Pine Bluff, Ark.	7,000 ft. 8 and 6-in	15	10	.....	P. W. Water & Light Co.
Dallas, Tex	25,000 ft. 6 and 4-in.	30 to 40	35	Unk'n	D. Tichenor, Supt.
Tempie, "	58,080 ft. 8, 6 and 4-in	15	Unknown.		G. E. Weller, Prest.
Weatherford, "	2,500 ft. 4-in.	10	2	.....	J. M. Bassett, Supt.

* To put in new standpipe; 60 ft. diam. by 35 ft. high.
† To erect new boiler house.
‡ Will double capacity of reservoir.
¶ May build new reservoir.
§ To build new reservoir.
** Building new reservoir.
†† "We want to put in a system of filtration."